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The Institute of Vitreous Enamellers
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

Institute of British Foundrymen

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C. W. Bigg, "Selworthy," Burley Lane, Quarndon, near Derby.

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BRITISH CAST IRON RESEARCH ASSOCIATION
The Registered Office and Laboratories of the B.C.I.R.A. are:—
21-23, ST. PAUL'S SQUARE, BIRMINGHAM
Telephone: Colmore 4274-4275. Telegrams: CIRA
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk
Telephone: 332

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A Slogan for Cast Iron

The British Ironfounders' Association is organising a competition for a slogan for cast iron. The Association is offering three prizes of £100, £50 and £10, and fifty consolation prizes of 10s. each. We have carefully read the ten very simple rules, and so far as we can see any of our readers, except the actual staff of the B.I.A., are eligible. It seems desirable to point out that this Association does not deal with engineering irons, but rather with those connected with housing, sanitation, cooking and heating. To our mind, when considering such an important factor as a slogan for cast iron the engineering aspect should also be envisaged, but cognisance must be taken of the fact that the man in the street is the ultimate user. The most prominent slogans of to-day are "Eat more fruit (or bread or fish)" and "Beer is best." Thus brevity is obviously a cardinal point. The first example is, to our mind, the better, as action is implied, but the second one makes use of "alliteration's artful aid." Moreover, "cast iron" is commonly used as a slang adjective in many walks of life. The racing man refers to a "cast-iron certainty," whilst the writer of detective stories will build up for his criminal a "cast-iron alibi," and the lawyer who defends the malefactor will insist that he has a "cast-iron case." The dictionary definition of this slang adjectival use of "cast iron" is "hardy or unyielding." We use the word slang because in truth cast iron is a technical word, and slang is not a vulgarism but the use of technical words in a non-technical sense.

A rumour has been going the rounds that some unnamed body is to spend £40,000 on popularising cast iron, but we can only think that some uninformed persons have been mentally confusing the appeal of the Council of the Cast Iron Research Association for added funds for the re-equipping of their laboratories. Nevertheless, such an action would be of permanent benefit to the foundry industry. The creation of a slogan is an excellent departure point, but much more is required, and so far as housing purposes are concerned we have every reason to believe that further action will be taken.

Any readers who wish to participate in the slogan competition should write to the secretary of the British Ironfounders' Association, 145, St. Vincent Street, Glasgow, C.2, for entry forms.

Prospects for 1938

We have expressed ourselves previously as definitely optimistic about business prospects for the coming year, in spite of the whispers about a trade slump, and we find ourselves in good company if statements to the Press made by leading industrial figures are any guide. There is no doubt that a recession is taking place in U.S.A., but prospects there for the spring look better. In the building industry on this side new housing seems to be being replaced by the erection of industrial and other buildings. Some sections of the trade appear to be suffering from the effects of excessive pressure on the public to buy after selling campaigns more usual in the States than in this country. The President of the Board of Trade now joins others who are in a position to know in stating that 1938 will maintain the progress made in 1937. We print elsewhere a recent statement made by Lord Dudley, President of the B.C.I.R.A. Lord Hirst, Lord Austin and Lord Riverdale all add their own impressions in the same direction, and railway heads have announced large expansion schemes. The uncertain factors are commonly stated to be the Spanish situation and the situation in the Far East. The main requirement as far as this country is concerned is confidence, and this lies at the very root of maintenance of the present volume of business. While we are agreed that unduly low commodity and raw material prices are bad, it may be fortunate that conditions prevent their rise to inflated scarcity values due to a general scramble for a limited supply. The rises thus brought about in the long run cause buyers to hold off and that is the herald of the slump. Of this there does not seem to be any real danger, and our forthcoming annual review issue should provide further details to emphasise the confidence with which the immediate future can be viewed.

The Steel Industry's Prospects

Reviewing the prospects for British trade in 1938, the EARL OF DUDLEY (President of the British Cast Iron Research Association), writing in the "Sunday Times," expresses himself in the following terms:—

"I am impressed with the persistent activity which rules in our iron and steel industry. Iron and steel enters into practically every form of manufacture, whether as buildings, as plant, or as raw material. In the year which is concluding we shall have produced 1,000,000 tons more steel than we have ever done before; yet the current rate of output is even higher.

"Such is the pressure for future deliveries that new furnaces and new mills are being pushed on with, and as this additional capacity comes into operation next year a greater demand at home and for export will be met and deliveries accelerated.

"An industry which is paying £50,000,000 every year in wages, which has laid out over £19,000,000 in the last two years on modern equipment, and which has just contributed £49,000,000 to the value of Britain's foreign trade, cannot afford and does not intend to look back with complacence on its recent revival. On the technical side, many steel firms are pursuing the development of fully-integrated works, embracing all phases of production, from coke ovens to rolling mills, and matching in efficiency any similar works abroad.

"The steelmakers have shown themselves prepared to take the risks necessary to all industrial progress, both by continuing to modernise and extend plant and by stabilising their prices for one year in advance, so as to give the maximum encouragement to all consumers of iron and steel products.

"I heartily welcome the confidence in this policy which many consumers are showing. No need is felt by them to accumulate stocks of steel, and current output is going straight into consumption. Certain public authorities, the railways, and others, have postponed non-urgent works so as to even out the demand for constructural materials.

"Taking account of factors such as these, with which I am in close touch, I view the course of trade in 1938 without misgivings."

Book Review

The Metallurgists' Manual. By T. G. Bamford, M.Sc., A.I.C., and H. Harris, M.Sc., F.C.S. Published by Chapman & Hall, Limited, 11, Henrietta Street, London, W.C.2. Price 7s. 6d. net.

This volume is a cheap edition of the "Metallurgists' Manual," by the same authors, first published in 1927. A short supplement has been added giving a list of typical compositions, properties and uses of engineering alloys, and includes in addition to a list of errata, some conversion factors and the details of a method of the estimation of alkalis in clays and silicates. The book provides a sound method for carrying out almost every analysis or assay commonly met with in mining and metallurgy. It deals also with the examination of fuels and refractories, pyrometry and metallography. A section of very great practical utility deals with smelting practice and methods of calculating furnace charges, and this is reinforced by a section of almost forty pages of tabulated information containing a vast amount of data in a concise form.

In a foreword by Prof. Thomas Turner, tribute is paid to the varied and extensive knowledge and experience possessed by the authors, and for this reason the book can be strongly recommended to all practising metallurgists. J. E. H.

American Notes

(FROM OUR AMERICAN CORRESPONDENT.)

According to the Foundry Research Engineer of the Climax-Molybdenum Company, the use of graphite (as ladle additions to molten iron or as blacking on the mould or core surface) has a more profound effect on the grain structure of cast iron than is generally recognised. Metallurgists have known for some time that a comparatively small amount of graphite added to molten iron initiates a considerable amount of graphitisation, thereby greatly reducing chilling tendencies and increasing graphite growth. Meanwhile, the effect of black-washed cores and moulds on casting has been given little attention, according to his report. Failure to consider such details may easily change a cylinder block from a saleable product to a candidate for the scrap heap as a leaky casting, or one having porous bore. This is especially true if the metal happens to be on the soft side. Chemical analysis will not usually reveal any carbon pick-up; nevertheless, the intensity of the action of amorphous graphite is sufficient to produce a marked change in structure. Conversely, with the exercise of reasonable control, the use of graphite on the surface of moulds and cores, especially where surfaces are normally too hard, can be made to work to advantage, the report concludes.

* * *

A new cobalt steel was described to members of the American Society for Metals by Mr. R. H. Harrington, of Schenectady, N.Y., research metallurgist of the General Electric Company. He told of a series of tests showing that the new alloy is "far superior to high-speed steel" in jobs requiring a smooth finish, lasting longer and cutting faster. It is particularly successful on Bakelite, he found. Mr. Harrington explained that when the alloy was used in machine-finishing articles which must present a pleasing appearance, "the finished surface was so good that the usual emery cloth finish was omitted. The life was about ten times that of high-speed steel." In addition, the alloy may be forged, swaged, rolled, drawn and machined. A further, and more difficult test, was also undertaken. A high-speed tool became dull after cutting 1 in. of material, while the new alloy was sharp after machining six 1-ft. lengths. It is the belief of outstanding metallurgists in America that this material will find wide use in the automobile industry and many other fields. The formula composition is 36 per cent. cobalt, 6 per cent. chromium, with slight amounts of carbon and vanadium.

* * *

The Michigan Steel Casting Company of Detroit is promoting its line of Misco "Centricast" products. The "Centricast" metal is formed in a revolving mould, an accurately-measured quantity of molten metal being introduced and forced outwards to the mould walls and held there under centrifugal pressure until it solidifies. The resulting cylinder is claimed to be accurately proportioned, with the outside diameter conforming to the mould in all respects, and the inside diameter or thickness controlled by the amount of metal poured into the mould. The new process makes thinner castings possible; whereas in the past thinness has been limited by foundry considerations that govern the minimum wall thickness obtainable by stationary casting, in many cases "Centricast" shapes of half the former weight have been produced. The range of sizes includes outside diameters from 2 in. to 20 in., and in wall thickness for $\frac{1}{8}$ in. upward. They are offered in any length and can be used with conventional castings of any shape where special assemblies are required. The products have proved serviceable as rollers for all types of conveyors; flanged, threaded and plain chemical piping; carburising and annealing boxes; hollow shafting, and rings of all kinds.

Random Shots

Whilst the "man in the street" is sitting back and enjoying that quiet lull which falls between the hectic festivities of Christmas and the equally hectic festivity of New Year's Eve, many prominent leaders of thought are being badgered by the Press to make learned pronouncements upon the prospects for the forthcoming year. Not being in a position personally to approach Mr. Neville Chamberlain, Sir John Simon, or Mr. Attlee, and Father Christmas having already departed for a rest-cure to the Canary Islands, "Marksman" has nevertheless been successful in obtaining the following representative views:—

From Colonel Blimp, President of the N.F.F.P.A., A.B.C., and D.E.F.—"It gives me the very greatest pleasure to record for the benefit of your readers my considered views of the trade prospects for 1938. Provided that Mr. Everyman can be induced to go on spending his money at the same rate as he did in 1937, trade will be much the same, but if he will only spend a little more, then industrial conditions undoubtedly will be better."

From Mr. Smith, manager of the Stanbridge Foundry.—"If we get more orders next year than we did this, we shall probably not be able to carry them out; if they are about the same I shall probably go balmy, and if they are any less the management will probably sack me."

From Mr. Jones, foreman of the Bijou Jobbing Foundry.—"If the management would only give me a new cupola, some new stoves, new sand-preparing plant, and a battery of moulding machines, then I don't believe I could get hold of the necessary labour to work them."

From Mr. H. S. Drill, Director of the U-K Ferrous Research Institute.—"The whole future of British trade depends on the intensive production and industrial application of scientific research. Since Tubal Cain started the foundry industry, I calculate that it has only spent something of the order of 0.000001 per cent. of its annual turnover on research."

From a Foundry Equipment Manufacturer.—"Prospects for 1938 turn on the political situation, but jar-ram turn-over machines turn on bearings and bearings require oil. *Nota Bene*."

From a prominent Refractory Material Manufacturer.—"The market conditions for the various refractory materials during 1937 were 'groggy'; moulding sand hardened considerably under pressure; ganister was patchy, and firebricks softened under hot demand."

In short, what thou hast sown, so also shalt thou reap, and only he who has sown a coining press can be sure of reaping a mint of money.

* * *

From Johannesburg comes the announcement that the South African Branch of the Institute of British Foundrymen is soon to hold its first annual dinner. Mr. Bigg, however, begs to state that he has already promised to dine with the local Branch of the "Buffs" that evening, and as the engagement is of long standing he regrets his inability to undertake the reply to the toast of the Institute. For the benefit of any other member who would like to attend, it can be stated quite definitely that it takes about 10 days to get there, but one glassful of Van der Hum has enough kick in it to get him back to his foundry before the boss has had time to miss him.

"MARKSMAN."

The Low-Frequency Induction Furnace

DEVELOPMENTS FOR MELTING

The pioneer work done by E. F. Russ in producing the low-frequency induction melting furnace is well recognised. As early as 1922 he drew attention to the functional, economic and metallurgical advantages of this type of furnace, and a year later the first low-frequency induction melting furnace of his own design was constructed for a brass foundry. Since that time the low-frequency induction melting furnace has achieved a solid position throughout almost the whole field of heavy metals, especially for the melting of copper alloys, such as brass, German silver and cupro-nickel.

This development has been extended to achieve practical success in other fields, as for instance the refining and melting of aluminium and aluminium alloys. Even in these two most recent fields of application the new system has passed beyond the stage of experiments, and is able to look back on many years' practical use.

Experience is now on record of more than 200 low-frequency induction furnaces on the Russ system, and during recent years so much that is new and valuable has happened in this special field that a comprehensive review seems desirable. Thus the following article deals with the principles underlying this method of furnace construction, its special properties, and the present status of its technical development, in order that the details drawn from varied practical experience which will follow may be understandable even by the less initiated.

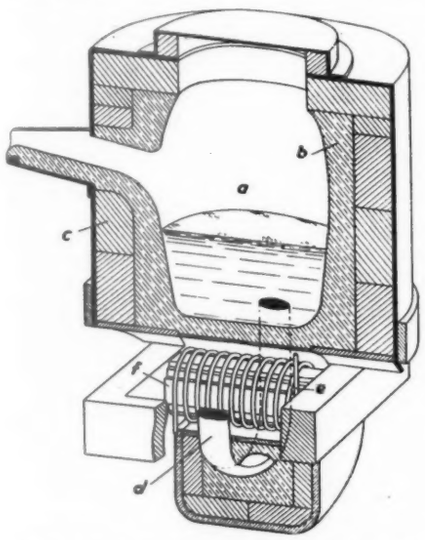

FIG. 1.—PRINCIPLES OF CONSTRUCTION OF RUSS LOW-FREQUENCY INDUCTION MELTING FURNACE.

a, Melting chamber. *b*, furnace lining. *c*, insulation. *d*, melting channel. *e*, primary winding. *f*, transformer core.

Construction of the Furnace

From the thermal point of view, induction heating represents the ideal case of electric heating. Instead of the heat being produced in separate heating elements and then transferred by radiation or conduction to the material, the electric current flows through the charge itself and heats it directly.

The furnace in which this action is caused to take place by the agency of a current of normal frequency is the low-frequency induction melting furnace. Fig. 1 shows its construction diagrammatically. The melting chamber (*a*) opens into one or more melting channels, (*d*) which encircle the primary winding (*e*) of a transformer; in this way the molten material in the channel and melting chamber forms the secondary circuit of the transformer, carrying a heavy current and receiving a correspondingly large input of heat energy as soon as the transformer is switched on. The heated material flows out of the channel into the melting chamber, colder material forces its way from the latter into the channel, and the resulting thermal current is further stimulated by electro-dynamical forces causing continuous and vigorous agitation of the bath, which ensures rapid and uniform heating and mixing of the whole of the contents of the furnace.

Melting

The furnace proper consists of a crucible-shaped hearth carrying a charging-hole cover and a pouring spout. The crucible shape gives the advantage that the surface of the bath is small in relation to the capacity, so that the loss of heat and loss of material by oxidation—which in any case is small in the induction furnace—is kept down to a minimum. The body of the furnace is surrounded by an iron casing, and under this is a thick layer of insulating bricks (*c*). The lining is made up with rammed refractory material (*b*).

Furnace Lining

The correct choice and construction of the furnace lining are matters of the first importance, experience having shown that its composition, dimensions, sintering temperature and correct treatment govern the whole operation of the furnace. Through co-operation with leading works in the refractory industry it has been possible to utilise the available knowledge regarding the properties of materials suitable for this purpose to such effect that suitable materials are now available to meet all requirements arising in practice. Further information as to the durability of the furnace lining on the Russ system, in the presence of different molten materials, is given later.

The method of construction is first of all to mix most carefully the refractory masses with various additions determined by the sintering temperature required and then to ram them in firmly. Special templates are necessary for the purpose, more particularly for forming the melting channels which are constructed simultaneously with the furnace lining. The designers have developed special methods and equipment which have proved effective for the purpose, and the result of the care applied to this matter is a melting chamber free from stresses or tendency to crack.

The completed work is slowly dried, is brought up to a high temperature, and is then filled with a quantity of molten material, bringing the furnace into operation.

Melting Channels

For most metals the vertical arrangement of melting channels as indicated in Fig. 1 is the most suitable, but there are a few special cases where horizontal channels are preferable. The correct arrangement of the melting channels determines not only the output and life of the furnace but also its suitability for different purposes of melting; to decide upon and calculate their position, shape and dimensions is an empirical science in itself, and it is the solution of this that has made possible the wide application now attained by the low-frequency induction furnace.

Furnace Transformer

Special care has been applied to the design of a transformer answering the requirements, since the reliability of the furnace in operation depends largely on the correct dimensioning and construction of this element. As a rule the windings are air cooled and powerful fans are provided. Usually the furnace is left with the current continuously on, even in the pauses between the actual operations, so as to keep the metal in the channel molten, and it is essential, therefore, to prevent any interruption of the cooling air. On this account many plants are fitted with two cooling fans, one of which serves as a standby, and where possible independent sources of current for actuating these are desirable. An alternative, under suitable conditions, is to make use of compressed air for cooling.

Tilting Device

All Russ induction furnaces are equipped with a tilting device operated by electric motor, the furnace being held in any position by means of a braking magnet. The tilting axis is situated directly below the pouring lip so that the molten material flows out in a uniform stream.

General Arrangement of the Installation

Fig. 2 shows diagrammatically how a melting installation is arranged. The furnace is built into a platform above floor level, and below this are the cooling fans and the tilting device, the latter consisting of a cable which passes over a circular segment at the lowest part of the furnace frame. On the platform is the switch cabin, which also contains the line transformer, connected between the furnace transformer and the mains; here the power is controlled in accordance with the nature and quantity of the charge, the length of the melting period, the pouring temperature, and the requirements as regards maintaining heat.

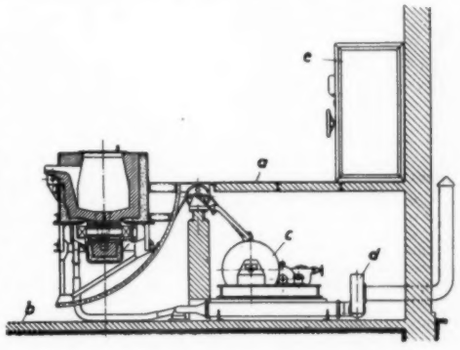

FIG. 2.—GENERAL ARRANGEMENT OF A FURNACE INSTALLATION.

a, Service platform. *b*, foundry floor. *c*, tilting machinery. *d*, cooling fan. *e*, switchboard with regulating transformer, etc.

On the switchboard the main and operating switches, safety devices, signal lamps, kilowatt-hour meter, wattmeter, voltmeter and ammeter are conveniently arranged. The service of the plant and supervision of the melting operation are easy and straightforward. Where the operating conditions make such an arrangement desirable, the furnace can be placed beneath the floor, for it is an advantage of electrical operation in general that the arrangement can easily be adapted to the conditions of the work.

Metallurgical Considerations

Reference has already been made to the movement which takes place in the melting channels, which results in constant agitation and stirring of the whole content of the hearth. The underlying principles of these phenomena are by no means simple, for, apart from the purely thermal rising tendency, a variety of electro-dynamical forces operate, according to the shape and dimensions of the channels and the hearth.

The reliability now attained in application of the low-frequency induction furnace, and the extension of its use even to the melting of cast iron and of light alloys, are the result firstly of these phenomena being understood.

The advantage of the agitation of the bath, which here occurs automatically, is the thorough mixing of the molten charge. The whole of the molten material becomes uniformly heated, and thus attains the correct temperature for pouring; at the same time impurities are driven off, and thus a dense uniform cast is obtained. This property of the induction furnace is of the greatest possible value, especially where any kinds of alloys are concerned, and it is the excellent quality of the cast metal so obtained that has brought about its rapid adoption in non-ferrous foundries. Correspondingly good metallurgical effects were found to attend the agitation of the bath when the furnace was applied to the refining of cast iron, and, finally, when the initial difficulties had been overcome, to the melting of aluminium and aluminium alloys.

This thoroughness of mixing makes it possible, at the present time, to use the induction furnace for melting even difficult alloys, such as aluminium bronze, or light metal alloys which contain lead. Further factors in improving the quality of the cast obtained from the induction furnace are the effectiveness of the supervision which is possible during the melting process and the ease with which the temperature can be observed and regulated, enabling the production of wasters to be avoided.

Low Metallic Losses

In the low-frequency induction furnace melting is effected with a small surface area over the bath and with the air well excluded. There is no possibility of local overheating at the surface of the bath, because the heating takes place within the charge from below upwards. All these factors combine to produce what is perhaps the most prominent feature of this type of furnace; that is, minimum metallic losses from oxidation.

This property makes it possible to keep compositions unchanged from beginning to end of the process; at the same time, the saving in raw material is very large.

TABLE I.—*Metallic Losses with Charges of Virgin Metal, in the Russ Low-Frequency Induction Melting Furnace.*

Material.	Metallic loss.
	Per cent.
Brass containing 58 per cent. Cu ..	0.9
" " 63 " " ..	0.8
" " 72 " " ..	0.6
" " 85 " " ..	0.7
German silver	0.6
Cupro-nickel	0.6
Copper	0.5
Duralumin	0.5
Silumin (Alpax)	0.5
Hydronalium	0.5
Pure aluminium	0.4

TABLE II.—*Life of Furnace Lining in Russ Low-Frequency Induction Furnace, with Continuous (24-hr.) Operation.*

Nature of charge.	No. of melts with one furnace lining.
Pure aluminium	5,000 to 10,000
Duralumin	5,000 to 10,000
Hydronalium (Al-Mg alloys)	5,000 to 10,000
Silumin (Alpax)	5,000 to 10,000
Brass containing 58 per cent. Cu ..	5,000 to 10,000
" " 63 " " ..	4,000 to 9,000
" " 72 " " ..	3,000 to 8,000
" " 85 " " ..	1,500 to 3,000
German silver	600 to 1,200
Cupro-nickel	600 to 1,200
Copper	600 to 1,200
Superheating of cast iron	150 to 200

The effect of operating economy is such that when a conversion is made to the use of the induction furnace the whole cost of the new installation may, in many cases, be saved in a single year through the avoidance of the loss which would otherwise occur from oxidation. The amount of the latter depends on the nature and conditions of the charge, and Table I gives figures for the most important of the materials treated in the Russ low-frequency induction furnace, all these data being averages obtained from practice.

Life of Furnace Lining

The only portion of the furnace which is exposed to wear in operation is the furnace lining. This fact is in itself an advantage by comparison with other types of furnaces in which delicate crucibles and expensive electrodes, cover blocks and the like continually call for renewal. In spite of this, however, the necessity to re-ram the lining of the induction furnace from time to time was at first looked upon as a disadvantage, until it had been learned how to control the composition and construction of the furnace lining in such a way as to ensure a very long period of life.

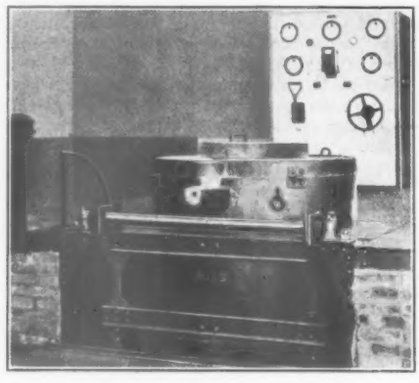

FIG. 3.—RUSS LOW-FREQUENCY INDUCTION MELTING FURNACE, TYPE IOA, FOR ALUMINIUM AND ALUMINIUM ALLOYS.

It is now possible, by making use of the correct ramming material and by exact compliance with the specification laid down for such work, to obtain a life of 10,000 or more melts when melting continuously; this figure is by no means out of the ordinary. The life of furnace linings also depends on the nature of the charge and Table II gives the results obtained in practice under the different conditions to which the furnace has been put.

Electrical Conditions

The reason for the high efficiency of the induction furnace is that the electric current flows through and develops heat directly in the charge itself. This property is possessed by the high- as well as the low-frequency induction furnace, but the electrical efficiency in the former is a good deal lower because, instead of the melting channels forming part of the secondary circuit, the charge is heated by eddy currents, necessitating a special transformer to change the supply current to high frequency. The low-frequency induction furnace, on the other hand, can be worked by a supply current of normal frequency.

Even the earliest Russ designs were arranged for multi-phase connection in view of the preference known to be shown by the electricity supply undertakings towards those large consumers whose loading of the phases is balanced. At the present time only the smaller types are arranged for single- or two-phase alternating current connection and all the larger types for multi-phase. Moreover, every precaution has been taken to minimise parasitic induction and to obtain as good a value of cos. ϕ as possible.

Table III contains electrical data for the brass type of furnace; these data indicate that the amount of current consumed in melting varies a great deal with the type of furnace and nature of the charge. The average values for current consumption which can be counted upon—but in practice the consumption is often much lower—are for instance as follows:—

For copper-zinc alloys containing up to 72 per cent. Cu, 190-230 kw.-hrs. per ton.

For high-percentage copper alloys, 270-330 kw.-hrs. per ton.

For pure aluminium and aluminium alloys, 460-560 kw.-hrs. per ton.

Labour Costs

Labour costs in the operation of the induction furnace are very low, only two men being needed, who can be trained in a few days. As in all electrical processes, the attention required is very simple, regulation being effected by altering the voltage, by means of the handwheel on the transformer, to whichever of the many steps provided is required by the conditions.

The tilting operation also is electrically operated. The cleanliness and hygienic conditions are particularly satisfactory, the operatives being practically free from any noxious vapours or gases.

Starting-up Metal

The induction furnace can be put into operation only if the secondary circuit is completed; there must, therefore, be present in the furnace at least enough molten material to fill the channel and the bottom of the hearth completely. When the charge is poured out this quantity of metal is left behind in the furnace, and the effective weight of the cast is therefore reduced below the capacity of the furnace as a whole by the amount necessary for starting up. It is desirable that during breaks in the operation the metal in the channel should be kept liquid by passing current through it.

It is possible, however, to pour out the entire contents of the channel and to allow the furnace as a whole to cool. Cases are on record in which this has regularly been done, but the operation is one which demands experience and which must be carried out precisely in accordance to instructions. In intervals of longer duration between operations the metal in the channel may simply be left to solidify, but this again involves the taking of certain precautions; the cooling and reheating must be performed slowly, and some practice is necessary. Experience shows that the simplest and safest method is to involve the relatively small loss caused by keeping the metal in the channel warm; the order of the current

TABLE III.—*Russ Low-Frequency Induction Melting Furnace for Copper-Zinc Alloys containing up to 72 per cent. Cu. (Type IOM).*

Effective weight of cast (approx.). Kg.	Weight of channel metal (approx.). Kg.	Power absorbed Kw.	Mean load factor (approx.). Cos.	Current consumption for maintaining temperature (approx.). Kw.	Power for ventilation. Kw.	Melting output per hr. (approx.). Kg.	Melting current consumption (approx.). Kw.-hr. per ton.	Type of current.	Cooling medium for furnace transformer.
100	40	26	0.8	11	—	100	210–230	1 or 2 phase A.C.	Water.
300	90	60	0.75	13	3	300	200–220		
600	200	140	0.7	18	5	600	190–210	Multi-phase.	Air.
1,000	300	200	0.7	23	8	1,000	190–210		
1,500	350	240	0.7	28	10	1,500	190–210		

NOTE.—The values obtainable in practice depend on the alloy, condition of charge, and desired pouring temperature.

consumption required for this purpose in proportion to the operation costs is shown by typical values in Tables to be referred to later.

Operating Results

The volume of operating results on record regarding the applications of the low-frequency induction furnace to nearly all melting operations is now so extensive as to preclude extensive quotation. Only a few practical examples, taken from the three important fields of application, are given, namely, copper alloys, light alloys and cast iron. In each of these groups the average values obtained in practical operation will be tabulated.

Copper Alloys

Many operating records are available for rolled, forged and cast brass, cast copper, bronze, copper, cupro-nickel and German silver, as well as for alloys containing iron, aluminium, manganese and silicon. The high quality of the casts, elimination of oxide inclusions and blowholes, and the uniformity of the structure are noteworthy. In alloys containing large amounts of lead the fine uniform distribution of the lead is outstanding.

In every case the current consumption and the total cost of operating depend not only on the nature of the alloy, but also to a very great extent on the local conditions of operating. The best conditions are obtained with continuous 24-hr. operation, but even single 8-hr. shift operation can be economically conducted. The ultimate purpose of the metal melted is also a governing factor; for instance, brass which is to be cast in sand moulds will usually be heated more highly than when it is to be poured into ingots for subsequent rolling. All these circumstances imply differences in the consumption of energy and in melting efficiency. The following is an operating example for brass containing 63 per cent. Cu:—

Russ low-frequency induction furnace	Type IOM 6.
Effective weight of cast	600 kg.
Pouring temperature, about	1,050 deg. C.
Melting period per charge, about	1 hr.
Total current consumption in continuous operation	195 kw.-hrs. per ton.*
Current consumption for maintaining temperature, per hr.	18 kw.-hrs.
Average metallic loss	0.9 per cent.
Life of furnace lining	7,000 melts.

Operating example for German Silver:

Russ low-frequency induction furnace	Type IOB6.
Effective weight of cast	600 kg.
Pouring temperature, about	1,300 deg. C.
Melting period per charge, about	200 kw.-hrs. per ton.
Current consumption for maintaining temperature, per hr.	20 kw.-hrs.
Average metallic loss	0.6 per cent.
Life of furnace lining	1,200 melts.

Light Alloys

The problem of melting aluminium and aluminium alloys in the induction furnace was one which could be solved only when special difficulties had been overcome. There was not only the question of arriving at the correct shape and dimensions of the channels, but also that of deciding what kind of refractory for the lining would best answer the entirely special requirements of the case. While these problems were still under discussion in the technical Press without any solution being reached, the Russ concern as the result of lengthy and expensive research succeeded in devising a suitable method of construction which could be adopted in practice.

The Russ design of low-frequency induction melting furnace for aluminium and aluminium alloys has passed beyond the stage of experiment and teething troubles. For a period of two years a series of such furnaces has been in continuous operation free from trouble, and recently they have been supplied in capacities up to 2,000 kg., or in one case up to 5,000 kg. These large furnace units are especially significant in that they enable the cost of analyses to be reduced.

The furnace linings in practical use have been proved suitable for the melting of pure aluminium, Duralumin, Alpax and Hydronalium (Al-Mg alloy), showing a life up to 8,000 melts without any sign of impending damage. It is important, in the formation of the special kinds of rammed linings, that no foreign constituent should be present—especially no iron or silicon which might be taken up by the molten metal,

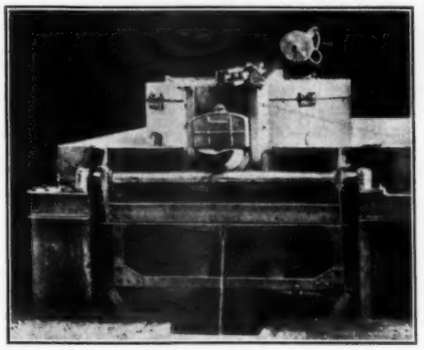

FIG. 4.—RUSS LOW-FREQUENCY INDUCTION FURNACE, TYPE IOG, FOR SUPERHEATING CAST IRON.

a point which has been proved by numerous careful analyses.

The agitation of the bath has to be so regulated in character and intensity that its effect shall not be harmful, but on the contrary highly beneficial to the process by purifying and mixing the melt and promoting degasification. In this way a cast perfectly free from gas or oxide is obtained. There is a further advantage in the fact that any kind of covering flux can be used without any fear of damage to heating coils, as there is none of these in the induction furnace.

The oxides which are inevitably formed in the melting channel are, of course, observed in the Russ furnace also, but by the adoption of a practical and patented form of channel cleaning device it has been found possible to render this phenomenon harmless. The process is an easy one to adopt, and can be carried out in a few minutes at regular intervals without danger to the durability of the rammed lining. The figures for rate of output, amount of loss by burning and current consumption are all very favourable.

The following is an operating example for Silumin (Alpax):—

Russ low-frequency induction furnace	Type IOA 5.
Effective weight of cast	500 kg.
Pouring temperature	750 deg. C.
Melting period per charge	2.5 hrs.
Total current consumption in continuous operation	469 kw.-hrs. per ton.
Current consumption for maintaining temperature, per hr.	23 kw.-hrs.
Average metallic loss	0.5 per cent.
Life of furnace lining	4,600 melts.

Operating example for Hydronalium (Al-Mg):

Russ low-frequency induction furnace	Type IOA10.
Effective weight of cast	1,000 kg.
Pouring temperature	750 deg. C.
Duration of melt	4 hrs.
Total current consumption in continuous operation	495 kw.-hrs. per ton.
Current consumption per hr. for maintaining temperature	28 kw.-hrs.
Average metallic loss	0.5 per cent.
Life of furnace lining	7,500 melts.

Cast Iron

In iron foundries the Russ low-frequency induction furnace has already been in very successful use for a number of years for the purpose of superheating cast iron and alloyed iron. For this purpose it is preferred to make use of the duplex process; liquid iron from the cupola is charged from a spout, or by means of a crane ladle, into the induction furnace, and is there refined by superheating, the temperature adopted in practice being of the order of 1,550 deg. C. The effect of the superheating is to refine the graphite structure and thereby to improve the quality, the mechanical strength being increased by 20 to 25 per cent. A cold scrap charge can also be melted down in the Russ induction furnace and used to produce high-quality electric iron.

The furnaces are built to take up to two tons effective weight of charge; these large units offer a special advantage in that they allow the making of heavy castings from specially alloyed metal. Moreover, the exceptionally low metallic losses and the consequent possibility of keeping the composition of the alloy unchanged, even for long periods, which is a result of the large capacity of the furnace, enable large numbers of small castings to be produced with practically uniform composition. This advantage has recently been found particularly valuable by an important iron foundry, where a difficult special low-carbon high-silicon alloy is being melted in a one-ton capacity furnace. The foundry in question has recently decided to erect four further furnaces of the same size.

The following is an operating example of the superheating of cast iron:—

Russ low-frequency induction furnace	Type IOG10.
Effective weight of cast	1 ton.
Pouring temperature	1,550 deg. C.
Superheating period	35 min.
Total consumption of current in continuous operation	80 kw.-hrs. per ton.
Life of the furnace lining	200 melts.

Structure of Tin and Zinc Coatings

Electrodeposition and hot-dipping are largely used methods of applying protective coatings to steel and other metals. The choice of the method to be used is influenced not only by manufacturing considerations, but also by the use to which the coated article is to be put, for the two types of coating, electrodeposited and hot-dipped, vary very much in their behaviour when subjected to deformation, corrosion and other causes of wear. There has been a good deal of work done to ascertain the fundamental differences between the two types of coatings, and this work, and some original contributions to it, are reviewed in a recently-issued publication of the International Tin Research and Development Council by D. J. Macnaughtan.

The microscope, X-ray and electron-diffusion have been instrumental in elucidating what is at present known regarding the structure of coatings. It is only in recent years that the technique for examining the cross-section of a coating of metal has been developed. It is also pointed out that hot-dipped metals may be regarded as extremely thin chill-castings adhering to the basis metal, and a view of the microstructure of the surface is not necessarily any indication of the underlying structure. Examination of the cross-section of thin layers shows the crystal structures to be very different according to the conditions of their formation. The reasons for the differences which occur in the case of tin and of zinc are discussed. When subjected to deformation, zinc coatings break sharply, while tin coatings stretch in a ductile manner, as shown in a number of photomicrographs. The effect of co-deposited matter in producing boundary embrittlement is also discussed.

Copies of the publication (Series A, No. 67) may be obtained free of charge from the International Tin Research and Development Council, Manfield House, 378, Strand, London, W.C.2.

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* Metric tons are used throughout this article.

Naturally-Bonded or Synthetic Moulding Sands?

By A. TIPPER, B.Sc.

(*Concluded from page 494.*)

Synthetic Sands

Examining the types of synthetic sand mixtures being used in this country and their properties, details of actual mixtures in use for various green sand work in cast iron, together with their chief properties, are set out in Table V. The outstanding differences in properties between these mixtures and those given in Table III are the moisture content only 3 to 3.5 per cent., and permeability much higher at 60 to 75, whilst the green bond at 6 to 8 lbs. per sq. in. is also somewhat higher. Two of these mixtures are from mechanised casting plants and the very economical proportions of new bonding material added should be noted.

It should be borne in mind, that in any sand mixture, the preparation of the sand by milling is most important to secure proper distribution of the bond, with consequent economy in amount of bonding materials required to produce certain results. It is a fact, mentioned by Shepherd in his Paper last year, that the green strength of many mixtures can be raised considerably by additional milling without serious detriment to other physical properties. This applies particularly to the mechanised plant where the milling time is cut down to a minimum in order to obtain the required output of sand, and for this reason it is usually necessary to commence operations with a higher proportion of bonding clay to sand than theoretically necessary, and gradually reduce the additions after the mixture has been in use for a short time. The same also applies to a natural bonded sand on a continuous system.

There are at least two foundries where the introduction of modern sand preparation plants resulted in the complete elimination of any new sand additions for at least 12 months owing to the better utilisation of the available bond, and with the addition of coal dust, burnt sand or core sand being added to make up bulk.

TABLE V.—*Synthetic Sand Mixtures in Use for Cast Iron.*
In British Foundries—Green Sand Moulding.

Sample no.	1	2	3	4	5	6
Type of base sand used	Leighton Buzzard	Southport sea sand	Sea sand and Leighton Buzzard bank sand	Erith silica sand	Leighton Buzzard No. 26 or Bedford silica	Scottish rotten rock
Particulars of mixture	System sand. 99.4 Old sand 0.56 New sand 0.06 Bond clay	54 Old sand 36 New sand 4 Colbond 6 Coal dust	91 Backing sand 3 Bentonite 6 Coal dust	System sand. 99.7 Old sand 0.25 New sand 0.05 Bentonite	70 Old sand backing 20 New sand 3.5 Colbond 6.5 Coal dust	System sand. 97 Floor sand 1 to 3 Rock sand 0.7 Coal dust 0.1 Wood extract
Class of work	C.I. baths for enamelling	Pot castings, high-duty iron	Light castings (facing sand)	Light castings in high-duty iron. 70 per cent. steel	Automobile cylinder castings. — Facing sand	Hydraulic engineering castings. Hand and machine moulding.
Moisture, per cent. ..	3.0	3.0—3.5	3.5	3.8	4.0	6.0
Green compression str., Lbs. per sq. in.	4.5—5.0	6.0	9.5	5.9	8.0	6.0
Green permeability, A.F.A. No.	60—70	70—75	70	65	50—60	53

Moisture

Now to consider the third constituent—moisture. The presence of moisture is necessary in both natural and synthetic bonded sands where a mineral bonding substance is used. It is present both in the combined form as part of the bonding minerals, which depend for their plasticity on this combined water, and also as free or excess water held mechanically on the surfaces of the sand grains or absorbed by the silt and clay. This excess of free water assists in the effective distribution of the bond over the sand grains, but it is the first to be converted to steam on the application of heat. This takes place very rapidly when molten metal comes in contact with the sand, and for this reason, moisture added to temper the sand either in excess or not properly distributed leads to trouble.

The combined effect of the bond and moisture is to impart plasticity (or "deformation" as the Americans call it), and coherence between the sand grains. There is an optimum moisture content for any sand mixture at which its strength is at a maximum value. This can be readily determined by experiment (see Table VI and Fig. 4).

Whether the sand in practice is used at this optimum moisture percentage will depend on several factors, such as the available bond, grain size, method of moulding, etc. For example, a heavily-bonded fine-grained sand will usually be worked with a lower moisture content than optimum, in order to avoid too plastic a mixture. No. 2 of Table VI is an example of this, the working moisture content being in the region of 5.5 to 6.0 per cent. This is a very usual figure for natural moulding sand mixtures for green sand work, as will be observed from tabulated details already given, whilst with synthetic sand practice, the moisture is usually around 3 per cent. This is partially accounted for by the smaller surface area of sand, and particularly by the absence of silt or inert bond.

Owing to the much higher permeability and composition of these sands, the loss of moisture during handling of the sand is more rapid than with naturally bonded sands. This becomes a serious problem in mechanised systems where the temperature of the sand rises to a dangerously high level after a few hours unless special methods are adopted for cooling the sand in the system.

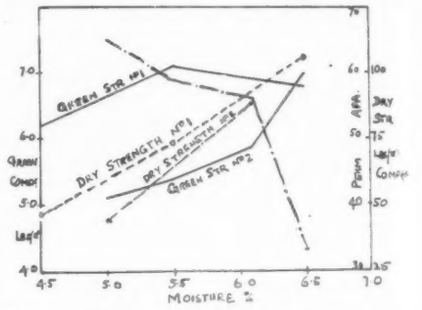

FIG. 4.—PROPERTIES OF SANDS MODIFIED BY MOISTURE CONTENT.

In retempering, the best method for a mechanised system is to add the greater part of the required water to the sand as early as possible in the cycle, in order to allow as much tempering time as possible, at the same time reducing the sand temperature, and only the final adjustment made at the mill of, say, the last 0.5 per cent.

TABLE VI.—*Variation in Properties of Sands with Moisture, per cent.*

Sand.	Moisture. Per cent.	Green compress. Lbs.	Green perm. A.F.A.	Dry compress. Lbs.	R.D.
No. 1	4.4	6.2	28.1	47.0	—
	5.5	7.1	23.3	73.0	—
	6.5	6.8	26.8	106.0	—
No. 2	5.0	5.1	65.0	44.0	1.45
	5.5	5.4	59.0	—	1.45
	6.2	5.9	56.0	88.5	1.45
	6.5	7.0	33.0	—	1.65

The loss of moisture can be reduced by the incorporation in the sand of such agents as glycerine and calcium or magnesium chloride, but moisture control is still one of the big problems in operating such plants. Recently in America the addition of fuel oil has been tried, to replace part of the coal dust addition, and it is stated that this enables a lower moisture content to be used with consequent less trouble in drying out.

The moisture content in such sands should not vary by more than ½ per cent. up or down for satisfactory results, and, according to Dietert, the correct amount of tempering moisture can be calculated for any sand from the following formula:—

$$\text{Per cent. moisture required} = \frac{\text{Fines}}{20} + 6.7 - \frac{\text{Green compression}}{5}$$

Where fines = percentage of sand grains retained on (200, 270 and Pan) in the Screen Test.

As examples.—Take, say, No. 2 Mixture of Table I.

$$\text{Moisture} = \left(\frac{30}{20} + 6.7 - 1\right) = 7.2.$$

For synthetic sands, however, the results appear too high.

The foregoing remarks and the mixtures given apply particularly to cast iron founding, but since synthetic sands are in use for steel, malleable and non-ferrous castings, a few remarks and details of such mixtures will not be out of place.

Steel Moulding Sands

For steel castings, green sand and dry sand moulding is practised; the dry sand is often bonded with an organic or oil binder, using a pure silica sand, with or without bentonite. Compo. may also be classed as a synthetic moulding material, and cement sand mixtures are the latest innovation for steel-casting moulds.

Typical Steel Moulding Sands of the Green sand variety are :—

(I)	(II)
75 per cent. Old sand.	84 per cent. Old sand.
25 per cent. King's Lynn silica.	15 per cent. Belgian.
1.5 per cent. Bentonite.	0.5 per cent. Bentonite.
0.25 per cent. Core gum.	5 per cent. Moisture.
Moisture, 3 to 4 per cent.	

Non-Ferrous Moulding Sands

In the non-ferrous foundry, though the naturally bonded sands are particularly suited for most classes of work, there are a few instances in which synthetic moulding sands have been called into service. For example, in the casting of Elektron or other magnesium-aluminium alloys, a silica base sand is in general use, bonded with bentonite, Colbond or an organic binder.

The production of special motor and aero engine castings of complicated form in both ferrous and non-ferrous metals is carried out in dry sand or oil sand moulds and cores prepared with mixtures of silica sand and a proportion of naturally-bonded sand.

Typical Dry sand Facing Sand (Motor Cylinder) :—

10 Shovels	Old dry sand (crushed).
4 Shovels	Old floor sand.*
1 Quart	Coal dust.
1 Quart	Colbond.
1 Quart	Bondol.

Moisture, 5 per cent.

* (Contains some Kingswinford Red.)

Cement-Bonded Sands

This method of bonding sand grains for moulding purposes was used about 20 years ago by Moldenke in America for coremaking. More recently the patented Randupson process has been developed in France, and there are now two foundries using the process under licence in this country. The mixture used for moulding consists of a clean well graded silica sand, similar to those used in a synthetic sand mixture, mixed with about 10 per cent. of Portland cement and from 4 to 6 per cent. water. Portland cement is produced by heating together lime and a siliceous clay or ground slag, and grinding the resulting sintered mass to a fine powder. On wetting this finely divided powder of complex silicates, chemical changes occur with the absorption of water and the mixture sets to a hard stone-like mass. These changes take an appreciable time to complete, and the damp mixture of sand and cement, which is prepared in the usual type of mill, remains in fit state for moulding over a period of two or three hours after mixing.

Usually this mixture is only used as a facing (approximately 1 in. thickness), the backing consisting of old crushed moulds or cores with sufficient cement added to give the required bond. Moulding practice resembles that used for oil sand work, the half moulds being stripped on to flat plates for "curing" or "setting." For the first 18 to 24 hrs. after moulding the mixture must be stored in a humid atmosphere or protected from losing moisture to the atmosphere if maximum "set" strength is to develop, after which the moulds are allowed to dry-off as quickly as practicable.

The curing or setting can be accelerated by increasing the room temperature, provided that the humidity is maintained to prevent loss of moisture from the moulds during the first period. Altogether the interval between moulding and pouring will be from 36 hrs. upwards, and when dressing the mould face with blacking, etc., the total time is increased up to two to four days.

The moulds are then assembled and cast in the usual way. Owing to the open grain class of silica sand used, the surface finish of castings made in untreated moulds is not always as smooth as desirable, and spraying or painting the mould face with blacking gives much better results for cast iron. Steel may be poured into untreated moulds or a special silica flour wash used. After casting the used moulds are crushed up for re-use. The "set" mixture does not recover its plasticity when retempered with water and must be rebonded with fresh cement.

Future Possibilities

Owing to the effect of the hardened cement in lowering the refractoriness (due to its basic character) and permeability of the moulding material if re-used, it is considered that it is best to use this old sand only for "backing," although by the use of special sand recovery plant it is feasible to recover a large proportion of sand for re-use in facing mixtures. The plant consists of a suitable grinding mill, screens and dust extraction plant, to remove as far as possible the dried cement and leave a mass of clean separated grains. All-new sand is recommended for steel. Further points worth mentioning are:—

(1) Possibility of using other types of cement or adding chemicals or substances to reduce the curing time.

(2) Control to close limits on moisture are essential in practice.

(3) Suitable storage for two to four days' production of moulds must be provided.

(4) Extended milling of the sand-cement mixture in preparation should be avoided to reduce moisture loss to a minimum.

Physical Properties of Cement-Bonded Sands

The following figures taken from a Paper by C. A. Menzel of the Portland Cement Association, U.S.A., show the physical properties of typical mixtures using a Missouri silica sand of medium grain size (50 to 100 mesh).

	Using normal cement.	Using H.E.S. cement.
Cement content ..	8.3—12.5 per cent.	8.3—12.5 per cent.
Green compressive strength	2.5—4.5 lbs. per sq. in.	1.5—2.5
Dry compressive strength (3 days after ramming)	600—800 lbs. per sq. in.	400—600
Permeability	130—95	120—100

This author advocates the use of a "High Early Strength" cement to reduce the "setting" time and obtain higher green and dry strength.

The properties of the sand-cement mixture may be compared with ordinary moulding sands and oil sands as follows:—

Green strength is lower than naturally-bonded sand mixtures but higher than most oil sand. Sufficient green bond to prevent sagging or distortion is obtained with correct cement and water contents. This mixture like other synthetic sands has good flowing properties, and does not require special skilled moulders.

The permeability is high and necessity for venting thereby lessened. In many respects it can be compared with oil sand practice except that the dry strength and strength at high temperatures is much greater. This is an advantage where there is considerable thickness of metal or against a runner where an oil sand might break down, but is a serious disadvantage when it comes to removing cores which are practically surrounded by metal.

According to the developers of this process the main advantage is in the reduction of labour moulding charges and standardisation of foundry practice, but it should be observed that this can be claimed for synthetic sand mixtures as a whole.

Estimated Cost of Mixture (Raw Materials Only)

Reckoning cement at 50s. per ton and silica sand at (1) 15s. per ton or (2) 10s. per ton.

Cost of facing mixture (1) 18s. 6d. per ton or (2) 14s. per ton; 10 per cent. cement.

Examples of savings in labour charges (supplied by Messrs. Hinckleys):—

(*a*) Iron foundry producing 60 tons of castings per week—overall labour charges reduced by 38s. per ton.

(*b*) Steel foundry producing 55 tons of castings per week—overall labour charges reduced by 40s. per ton.

The cost of preparation is about the same as for other sands, but if recovered sand is used then sand recovery plant must be installed. No drying stoves or ovens are required in this process, thus cutting out a considerable cost on dry sand work, whilst owing to the higher strength of the dry mould, the total amount of sand used will be less. The process is being used for steel, cast iron and non-ferrous metals, and constitutes another example of the replacement of naturally-bonded sands by a synthetic mixture.

Analysis of cement bonded sands: SiO_2, 83.3 per cent.; CaO, 7.0 per cent.; Al_2O_3, 2.0 per cent.; MgO, 0.5 per cent.; Fe calculated as Fe_2O_3, 4.0; alkalis, 2.0, and loss on ignition, 1.74 per cent.

The next consideration is the relative advantages and disadvantages of the two classes of sand. These may be briefly summarised as follows:—

Natural Bonded Sands.

Advantages.	Disadvantages.
(1) Low cost of sand in most districts.	(1) Skilled operatives often necessary for moulding.
(2) Strict control of mixture not essential.	(2) Poor permeability means much venting necessary, and ample coal dust.
(3) Excellent surface finish can be obtained on castings with due care in sand preparation, etc.	(3) Variable moulding results and scrap losses often high, particularly in mechanised plants, due to short milling time. Sand pellets occur.
(4) Particularly suitable for non-ferrous work, and with metals having low surface tension.	(4) Accumulation of old sand or cost of dumping.
(5) Moulds can be readily patched or sleeked.	

Synthetic Sands.

Advantages.	Disadvantages.
(1) Ease of moulding, hand or machine, *i.e.*, free flowing.	(1) Not usually easy to patch.
(2) Good physical properties ensured by regular control—reduces scrap losses.	(2) Loses moisture rather rapidly, may cause "murly" or weak friable edges on moulds.
(3) No waste sand to dump.	(3) Higher first cost of sand. Finish not always satisfactory.
(4) Selected properties of sand to suit class of work and moulding equipment.	

Costs of Sands

Entering into more detail with some of these points:—

Since costs are always of first importance it is interesting to compare natural and synthetic sand mixtures on this basis.

TABLE VII.—*Sand Costs.*

(1) *In this country*—

Cost of new moulding sand varies from 5s. to 10s. per ton d/d.
„ silica sand or sea sand varies from 6s. to 20s. per ton d/d.
Cost of bentonite .. say £10 per ton.
„ other clays say £3 to £6 per ton.

(2) *In America*—

Cost of new moulding sand (local) 7s. 6d. to 12s. 6d. per ton d/d.
„ silica sand .. .. 10s. to 15s. per ton d/d.
Bentonite .. .. .. £4 to £4 10s. per ton.

(3) *Cost of batch milling.*

	Natural.		*Commence synthetic.*	
A	80 old = nil	Silica sand ..	95 at 15s.	71.25
	20 new = 10	Bentonite ..	3 at £10	30
	2 C.D. = 4	Coal dust ..	2 at 4s.	4
	102 tons £14			£105.25
	Cost = 2s. 9d. per ton.		21s. per ton.	

Revivify.

B	77 .. = Nil				
	33 .. = £16 10s.	Old sand ..	87.5 ..	Nil	
	2 .. = 4	New sand ..	10 at 15 ..	7.5	
		Bentonite ..	0.5 ..	5	
	£20 5s.	C.D. ..	2 ..	4	
				£16.5	
	Cost = 4s. per ton.		Cost 3s. 6d. per ton.		

Taking first of all *batch mixings* of facing sands, and ignoring cost of preparation as common to both. The figures of first cost are definitely in favour of the naturally-bonded mixture, *i.e.*, 2s. 9d. to 4s. per ton, as against 21s. per ton, though this does not take into account any cost of dumping old sand when using naturally-bonded sand. A price is assumed of 10s. per ton for new naturally-bonded sand for calculation, which it is realised is high for some districts (such as the Midlands for instance), unless the sand is ready milled or sieved. Yet against this must be reckoned the 15s. taken for silica sand which is also high for many areas near to supplies of suitable silica sand.

TABLE VIII.—*Comparison of Sand Costs in Continuous Sand Systems.*

System.	No. 1.	No. 2.	No. 3.	No. 4.
Type of sand	Natural	Synthetic	Synthetic	Synthetic
Total sand in system. Tons	24	70	62	35
Rate of sand circulation. Tons per hr.	24	60	50	30
Amount of new sand added per day or 8-hr. shift. Tons	1.1	3.0	1.0	0.5
Amount of bonding material added per day or 8-hr. shift. Lbs.	Nil.	600	400	50
Price of new sand. Per ton	10s.*	21s.†	6s. 6d.	15s.
Price of bonding material	—		£10	£6 10s.
Per cent. new sand addition	0.57	0.6	0.25	0.02
Cost of additions per 100 tons of sand treated	5s. 9d.	12s. 7d.	10s. 8d.	1s. 10d.
Ratio of metal poured per ton of sand used for moulds	1 cwt. per ton	—	0.9–1 cwt. per ton	—

* Ready milled.

† Cost of prepared mixture.

After the high initial cost of the synthetic sand, the maintenance or regular week to week cost is very much less, and taking a representative addition of 10 per cent. new silica sand with 0.5 per cent. bentonite, this mixture only costs 3s. 6d. per ton, without any dumping costs. On continuous sand plants the management is able to get down much more closely to actual sand costs. Details are given in Table VIII of actual costs of operating sand systems on a natural sand and three synthetic mixtures. It is obvious from these figures that apart from first cost of stocking the system, there is very little difference in actual running costs for sand maintenance.

Cost figures for American practice submitted by Dietert show considerable saving, varying from 2s. 6d. to 5s. per ton of metal poured when operating a specially bonded synthetic sand, in comparison with the use of naturally bonded sand mixtures, with new sand costing from 11s. 2d. to 14s. 3d. per ton. This is achieved by eliminating almost completely facing sand, using fettling shop sand, burnt core sand, and used moulding sand. This of course is also being adopted in several foundries in this country.

Working Properties

The practical man will naturally want to consider the working properties of these sands, and what sort of castings are produced in them, particularly as regards surface finish on the castings. To illustrate what is being done a number of examples of castings made in regular production in synthetic sand from different foundries were exhibited. These were in all cases cast green, and represented varying sections and composition of metal, high and low phosphorus, common and engineering irons.

TABLE IX.—*Classified Characteristics of Sands for Various Purposes.*

Purpose.	Facing sand. Permeability.	Bond. Lbs. per sq. in.	Moisture. Per cent.	Coal dust. Per cent.	Heap sand. Permeability.	Bond. Lbs. per sq. in.	Moisture. Per cent.	Coal dust. Per cent.
For castings from ¼ to 4 cwts. ..	75	9.0	3.5	5.5	90	8.7	3.5	3.0
For castings 1 to 2½ cwts.	85	8.5	3.5	5.5	110	7.0	3.5	3.0
For malleable castings from 20 lbs. to 1 cwt. to stand high temperature	100	8.5	3.0	5.0	120	7.0	3.0	4.0
For castings from 1 lb. to 80 lbs. ..	70	9.5	3.5	5.5	75	7.0	3.5	3.0

It is suggested that although the finish is not perhaps as good as the best obtainable with natural bonded sands, it is really very satisfactory. At first the results were often rather poor, but by slightly modifying mixtures and adjusting the grain size of the sand, considerable improvement has been made from the point of view of surface finish.

The addition of a small proportion (say 10 per cent.) of a fine grained natural bonded sand, or burnt foundry sand, is the usual method of procedure, and although this does reduce the permeability, this can be held at a satisfactory figure, once the requisite amount of fine grained sand has been introduced into the system, or general heap sand. Therefore, under this heading of synthetic sands are included those mixtures which contain a proportion of naturally bonded sands, and it is thought that in future instead of choosing a perfectly clean silica sand for the base of a synthetic mixture, the most suitable sand will be found to be one possessing already a coated grain (*i.e.*, grains already possessing a film of clay or bonding substance). In theory there is no reason why one should not use silica grains with a natural bond already present, provided that one can obtain a satisfactory grain size, and also that the bond is sufficiently refractory for the purpose. Such sands are to be found in this country. An example of such a sand reached the author quite recently from the Sheffield district. The sand has beautiful worn rounded grains of pure quartz, with a very fine coating of clay, so evenly distributed that it is not noticeable to the naked eye. It contains just under 1 per cent. of dry clay substance sufficient to cause the grains of sand to clot or adhere weakly when dried.

The difficulty usually is to get rid of undesirable fines or mineral matter which is not effective as a bond producer, but merely absorbs water and clogs up the pores or voids in the sand.

In a number of mechanised sand plants operating with natural sands, classifying or dust extraction plants are fitted which aim at removing the fines from the system. This is an attempt at correcting an inherent property of the sands being used, and in general these also remove a considerable amount of valuable sand. When dealing with a synthetic sand, there is no necessity for such a plant. There is every reason to believe that in practice there is very little, if any, disintegration of the sand grains, apart from those sufficiently near to the actual metal to be subject to extremely rapid heating. Such sand is almost entirely removed with the casting to the fettling shop. Silt is more likely to be produced by breakdown of the bonding material, particularly if this be of a crystalline nature, but here again the dehydration or destruction of bond is only in that part of the mould close to the metals, and with re-use of the sand the dehydrated or decomposed bonding material either forms a thicker coating on the silica grains or is agglomerated (probably by the distillation products of coal dust or other bonding substances added) without impairing the permeability of the sand.

Conclusions

To conclude this section of the Paper, some of the desirable properties of moulding sands have been listed which should be sought in choosing a new sand.

(1) Choose a sand with close grading of the grains in order to secure the required permeability, and casting finish. Permeability (green) of 50 to 70 is satisfactory for cast iron.

(2) The new sand should not contain more fines than desired in the working sand, and 10 per cent. passing through a 200 mesh is the approximate limit.

(3) The refractoriness of the sand should be sufficiently high to prevent burning on; this, of course, depends on the type of metal and casting temperature, etc. "Not fritted" at 1,300 deg. C. is suggested as suitable for cast iron.

(4) Choose a bonding material with a high bonding power and good life.*

As a final example of a specification for synthetic sands, Table IX reproduces some figures published by the Ford Motor Company, of Dagenham, in one of their recent booklets, showing characteristics of sands for four classes of castings.

It is hoped that the above remarks have not been unduly biased by personal opinions; the facts are stated as clearly as possible for both sides. The object is to induce a more intelligent and economical use of domestic resources of moulding sands in the future.

Finally, the author wishes to express his thanks to those individuals and firms who have so generously supplied details of their mixtures, provided samples of sand and examples of castings, and to the directors of his own company, the Fordath Engineering Company, Limited, for granting him the facilities for the preparation of this Paper.

* Determined by retempering a sample of the sand after heating to temperatures over the range 300 to 1,800 deg. F. (150 to 1,000 deg. C. in increments of 200 to 300 deg. F.), and measuring the drop in green strength produced. A sand showing an average loss over the whole range of not more than 60 per cent. is considered to have a bond with good life or durability.

An All-Welded Factory Building

Foundrymen, as was apparent at the last International Foundry Conference in Paris, have considerable interest in welding as a means of construction, repair and composite fabrication. Whilst the competition of weldings with castings is very much their concern, the ousting of riveted structures can be dismissed as being outside their business. In these days the factory building is just as much a tool as the moulding machine, a riddle or a shovel, and the potentialities offered by an all-welded structure are of serious interest to the foundryman. For instance, when mechanisation is envisaged it is often found that there is insufficient headroom, that a multiplicity of girders spoils the layout and hinders production. It is thus germane to detail the construction of a new factory for the manufacture of welding electrodes now under construction for Murex Welding Processes, Limited, at Waltham Cross, which is to be one of the largest all-welded steel-frame structures of its type in the country. It is expected to be completed and in production early in the New Year, some five months after the raising of the first girder. A model of the building, exhibited at the recent Foundry Exhibition at Olympia, aroused great interest among structural engineers.

Electric Arc Welding Employed

The welding throughout was carried out in the shops and on site, by the electric arc process, using Murex welding plant and "Ironex" electrodes. Some idea of the speed of working by this method is given by the fact that the light secondary girders (of which there are 48 in the structure) were turned out at the rate of three per week by a gang of three welders and four erectors, from cut lengths delivered on site. The welding of these girders was carried out on a 125-ft. jig.

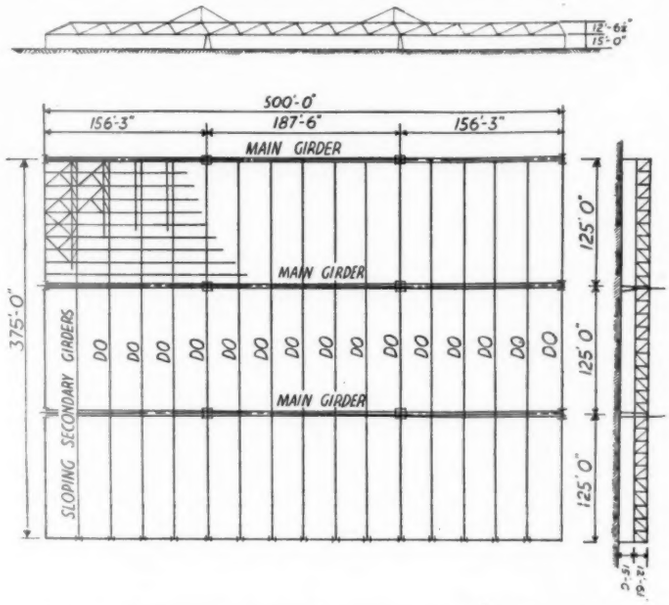

FIG. 1.—ARRANGEMENT OF STEELWORK OF NEW FACTORY OF MUREX WELDING PROCESSES, LIMITED.

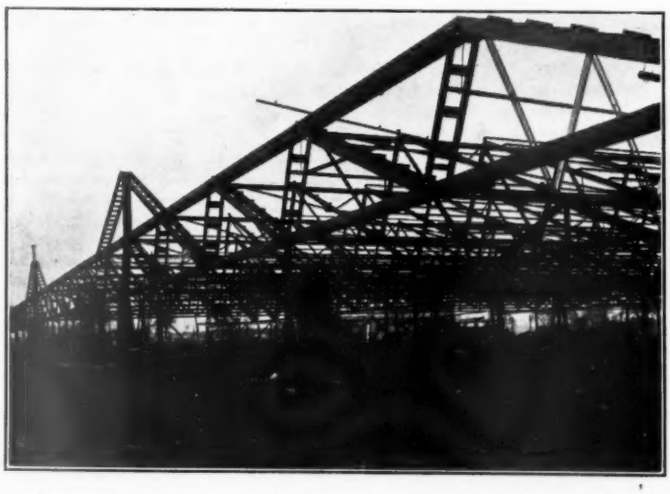

FIG. 2.—FACTORY IN COURSE OF ERECTION, SHOWING MAIN GIRDER 500 FT. LONG.

The factory at present covers an area of 4½ acres in a rectangular block 500 ft. by 375 ft., and provision is made for future extensions in two directions. The roof, which is of the standard north-light type, is glazed with ¼ in. wired glass and sheeted with asbestos-cement corrugated sheeting. It is lined internally with fibreboard.

Features of the Steelwork

The main features of the structure are shown in Fig. 1, and the design of the steelwork will be seen to be distinctly unorthodox. The primary consideration was the provision of the maximum possible unobstructed floor space, a feature which will appeal to foundry executives. A number of schemes were considered, but a design with only four internal columns was finally adopted as being the most practical and economical.

The purlins, which are 3 in. by 2½ in. by ¼ in. angles, are carried on joist rakers spaced 12 ft. 6 in. centres. These were preferred to the more usual lattice trusses as giving a lighter structure, as well as dispensing with the unsightly maze of light internal members usually seen on this type of job. The ends of these joist rakers are carried on 125-ft. span lattice girders, spaced at 31 ft. 3 in. centres and weighing approximately 4½ tons each. These girders have their axis inclined at 66 degrees to the vertical so as to lie in the same plane as the glazing.

Running the entire length of the structure, and carrying the ends of these lattice girders, are three main girders each 500 ft. long and weighing approximately 70 tons. These are designed to be continuous over two intermediate supports, and in order to take care of the large positive bending moments the effective depth of the girders is increased at these intermediate supports by the addition of the hump.

The total weight of the steelwork in the structure is approximately 850 tons, giving a weight of 10 lbs. of steel per sq. ft. of floor space.

Strength, Lightness, Rigidity and Economy

Considered as a whole, the structure represents not only a triumph of the welder's art, but also the latest and most spectacular advance in a method of construction which is rapidly making headway where strength, lightness, rigidity, speed of erection and economy of materials are the main considerations. The electric welding process may therefore be said to have given a new impetus to steel-frame building. In welding design, as compared with riveting, steel is used most economically, owing to the absence of gusset plates, light bars, and the like. For the same reason, maintenance is simpler, and since most of the welding is done on site, there are few, if any, shop overheads.

Catalogue Received

Air Heating and Circulation. An important pamphlet (No. S.F. 252) has been issued by Davidson & Company, Limited, of Belfast, which deals with the Sirocco unit air heaters and circulators. The importance is stressed because one of the objects of the new factory legislation is that all workshops should be essentially comfortable places in which to work. Early grumbles of expense can be discounted by the fact that not only will work be created for the foundries but also production will be increased. The types covered have either steam or solid fuel as a source of heat, whilst two sizes are available, made as nine distinct models. The various models change in design with the steam pressure available, the nature of the drive and, of course, in the case of solid fuel. The full-size models give 180,000 or 220,000 B.T.U. per hr. Full technical data are included.

THE LONDON MIDLAND & SCOTTISH RAILWAY COMPANY'S permanent way renewal programme for next year includes the complete relaying of 605 miles of track, including points and crossings, with new materials throughout; another 80 miles will have new sleepers, and 36 miles will have new rails.

Properties of Chilled Shot and Grit

An excellent reception was accorded to the joint Paper* by Mr. J. E. Hurst and Mr. J. H. D. Bradshaw when it was read before the Sheffield Branch of the Institute of British Foundrymen. The discussion which ensued brought out a number of interesting considerations, most of which indicated the real necessity for the prosecution of further research work.

Changing Conditions

THE BRANCH-PRESIDENT (Mr. J. B. Allan), opening the discussion, observed that they had heard a masterly review of the properties of that material used in foundries for the many purposes that the authors had mentioned. He (Mr. Allan) could not help recalling the time, some 12 years back, when he had more interest in shot- or sand-blasting than he had now. It was then extraordinarily difficult in this country to get any so-called sand-blasting plant other than the room type where the man had to operate from inside. At that time he was interested in getting a plant of a continuous type and was quite unable to do so in this country. It was certainly all "sand" in those days, despite the objections to it that had been mentioned that evening, and possibly many others. Shot was then just in its infancy, and was being put forward as an alternative which might or might not be satisfactory. Since then a great deal of development work had been done in regard to shot, and Mr. Hurst and Mr. Bradshaw had covered a great deal of this ground.

One particular point mentioned in the Paper in which he felt interested concerned the comparative results from the air-projected shot and the mechanically-projected shot. The latter was a modern development within the last few years. Another point was that of the embedding of the shot in a white-metal matrix for use in determining the hardness. All the very high degrees of hardness probably meant that in the white metal there was some slight give, and the actual hardness might be even higher than the one shown. Perhaps Mr. Hurst would give them some information on that point.

Compositional Influences

MR. J. ROXBURGH remarked that, as usual, the members had learnt something of interest from the authors, and, as was also usual, they had been given details of investigational work that pointed the way along which further research could be done, and from which something very useful could be obtained. The question of the composition of the metal of the chilled metallic shot appealed to the speaker as being interesting. Apparently the properties depended on low manganese, high sulphur and high phosphorus contents. As one who made chilled castings, and referring to hardness figures, Mr. Roxburgh said he had more or less to make comparisons with a Shore number. The figures mentioned seemed to him very high, and he wondered if the authors had made any investigations with other materials, for instance, a high-manganese iron with low sulphur—say a manganese content of 1.5 per cent. or thereabouts. He thought the authors would in that way get strength and hardness as well. He wondered if there would be any objections to an iron of that composition.

He was also interested in the question of the solidity of the little chilled shots, and wondered if there were any means of overcoming this phenomenon. He would like the authors to describe how the shot was made. Apparently the metal was quenched in water, and he wondered, if the metal was submitted to some pressure or other process before being ejected into the water, whether that would make any difference. Another point to which the authors had referred was in connection with the comparison between a metallic shot and a silica grit, where it was claimed that the wear of nozzles with the metallic shot was much less than that with the sand. He wondered in that instance of what material the nozzles were made. He also wished to know if the authors' investigations as regards iron castings had been carried out on the various types of material. For instance one could get a hematite casting of very soft material, or on the other hand, one of high hardness value, and he wondered if the life the authors obtained with their metallic shot varied on that account.

Hardness Determinations

MR. HURST first dealt with the Branch-President's sugestion that, perhaps, had the specimens been embedded in something harder than white metal, they might have shown a still higher hardness. He pointed out, however, that in investigating the hardness variations of a shot they used a very low load. The pressure was only a 10 kilogram load. With that load on the particle size of shot they had investigated they did not anticipate that there had been any deficiency introduced into the determination due to the metal in which it had been embedded. With smaller grain they would find it necessary to use a still lower load. The figures given could be regarded as reasonably accurate. In regard to Mr. Roxburgh's question of composition and strength, Mr. Bradshaw, in his notes, had suggested that some of the experimental work they had done so far with high manganese tended to give a shot of a brittle character, and consequently a short life. He did not think that Mr. Roxburgh's suggestion of submitting the metal to some pressure before it was ejected into the water would overcome the question of solidity. Surely it was inevitable that the grains of shot, like steel ingots, must start to solidify from the outside surfaces first, the last portion of the material to solidify being in the centre. This resulted in an openness of character in the grain which was equivalent to the amount of shrinkage in the small volume of the shot. Respecting the type of nozzles used, they had no information beyond the fact that they were hard white-iron nozzles. It was customary to use hard white-iron nozzles such as were made by the malleable ironfounder; it was presumed that the nozzles used in the experiments were of that type.

Nozzle Life

MR. BRADSHAW said that, since the compilation of the Paper, he had come across a concrete example in regard to the comparative life of nozzles. The experiments were carried out with hard white cast-iron nozzles of 9-mm. diameter working at a pressure of 35 lbs. When using sand the average life of a nozzle was 16 hours, but when using flint the life was reduced to 7 or 8 hours under the same conditions; yet when they changed over to chilled iron grit the life was then of the order of three weeks. It really made a serious difference to the life of the nozzle.

Elastic Limit and Abrasive Qualities

PROFESSOR J. H. ANDREW said that the possibility of the hard particles being pushed into the white metal during hardness testing had struck him also, as it required very little pressure to do so. Did Mr. Hurst find any difference between the hardness of the large and small particles of shot? If not, this supported his contention that his method was sound.

The micrographs were most interesting. One which was shown on the screen suggested that the metal had been cast at a high temperature as compared with the others. The structure of the shot described by Mr. Hurst as being particularly good indicated that a considerable amount of austenite present acted as a reinforcement for the hard carbide and martensite. Was it a fact that, in using spherical shot, after a certain amount of use the shot became of the angular type and therefore better for its purpose?

Could the authors tell him whether a high elastic limit was a valuable property to be sought in the material for shot? One would expect that a high value for the elastic limit would be associated with better abrasive qualities.

Round and Angular Shot

MR. BRADSHAW, dealing with Professor Andrew's question concerning the efficiency of the material, said that the round shot as described in the Paper was in contradistinction to the grit. The shot was less efficient than a grit, and in use it often broke up and became irregular. When it did that it virtually became more efficient than it was in the first place. Without going back to the genesis of the manufacture of grit or shot, it was, of course, known that in the beginning the first experiments were made on a round material, which was essentially a shot. It was then thought that that material was quite efficient, but as the majority of people who used that material did so with the object of covering the work treated with some other substance, or coating it according to some other process such as enamelling or painting or even galvanising, it was found in those days that the shot was not as efficient as the sand then used, the reason being that the shot in use gave what was called in the trade a "peened" surface—that was to say that if one examined the surface of the work treated one would find it was quite smooth. From those days the tendency in the trade had been to move away from shot and now people liked to use what was called grit, which was actually a form of crushed shot. The grit was essentially a material that contained a number of irregular pieces. These caused it to have a very rapid action, in addition to which a furrowed surface was produced. The greater part of the production of material made today and sold in this country was what was called the angular or grit type. Round shot was not so much used.

Nature of Working Conditions

MR. HURST, speaking of casting temperature, said that this was found to be a very important matter, not only from the structural point of view, but also as it affected shape. He hoped that the time would come when this would be investigated further. He was in agreement with Prof. Andrew in his interpretation of the effect of microstructure on the behaviour of the shot. In regard to the qualities of the round shot, there was probably an optimum period in its life: that was to say, its efficiency varied along a sort of curve. It passed through an optimum period in use and finally wore away and was useless. As Mr. Bradshaw had stated, round shot seemed to be out of favour in the castings' cleaning department. The largest use of round shot to-day was in stone-cutting and polishing. He believed that in this case, also, there was an optimum period, and that it was not necessarily at its best when it was new. After some use it gradually got better and then fell off. The elasticity of the material was very important as distinct from plasticity.

Replying to further points raised in the discussion, Mr. Hurst said that in the range of sizes they were able to deal with, under a 10-kilogram load they did not find any difference in hardness when investigating the hardness of samples of shot of different particle sizes. In pressing the

(*Continued on page* 510.)

* "Some Notes on the Properties of Chilled Metallic Shot and Grit Used in Sand-Blasting," FOUNDRY TRADE JOURNAL, December 9 and 16, 1937.

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particles into the metal, they used a specific pressure. A pressure of several hundreds of pounds was required to press and hold them in position. He only mentioned this to give some idea of the fact that the particles were really firmly supported in the metal. The only difficulty they had was that sometimes they came to a size of particle that, with a 10-kilogram load, simply did nothing else but split up. They regarded that as the criterion. If they could get a firm uniform impression, they were satisfied. Over a range of sizes below about 18's, they could not test at all with their present apparatus, because this was limited to the 10-kilogram load. One of the lantern slides exhibited showed fragments of shot broken by being pressed in.

Nozzle Wear and Efficiency

MR. H. WHARTON said that users of material could not fail to be interested in the experiments that had been brought to their notice. In following these experiments, it had struck him that more of them would have to be undertaken if anything like reasonable results were going to be obtained to help Mr. Hurst and Mr. Bradshaw in their conclusions on the merits of angular grit or any other abrasive. The velocity at the nozzle was certainly one of the things chiefly to be considered. The velocity was governed by the power behind the air. Once the nozzle started to wear away, the blasting efficiency diminished very quickly. Another point was that the abrasive, when it was new, worked quicker than when it had been in operation for some time, not only because of it tending to break down, but because it got dirty. They then got dust which was not carried away by the dust exhaust system, and it became embedded in the surface of the abrasive. Another thing that had to be watched was the fact that in compressor plants condensation was a bugbear, as a fruitful cause of stoppages. These stoppages took up the time of the foundryman who always measured the value of abrasives by the tons of metal castings cleaned in a specified time. Thus stoppages were something that must be taken into consideration. The operator had always to be considered. When the operator was plying the nozzle to a casting, he must strike at the right angle in order to get the most efficient cutting angle. This depended to some extent on the skill of the operator himself. Some operators were much better than others. Thus, in making comparative tests, it was advisable to have the same operator all the time.

Mechanical Projection Suggested

MR. HURST said he appreciated Mr. Wharton's remarks and the significance of controlled conditions. He (Mr. Hurst) ought to have taken the opportunity of paying tribute to the work done by Mr. Neville. Perhaps the only comprehensive investigations done on sand-blasting were those done by Mr. Neville. He carried out very comprehensive tests on the question of nozzle size, nozzle velocity and angle management of the shot, and showed the very great importance that these factors had in economical sand-blasting. Since that time very little further work had been done, and Mr. Bradshaw and he (Mr. Hurst) took the view that there was considerable room for further improvement, both in the direction of the quality of the material itself as used for the abrasive and in plant design. A lot of what Mr. Wharton had said might be used to support the mechanical sand-blasting machine in contrast to what he would call the pneumatic sand-blasting machine. They all appreciated the significance of nozzle wear. Not only did nozzle wear have the effect of reducing the efficiency of each operation but it put up the cost. It was in that way a sort of double-edged weapon.

Rubber Nozzles

MR. S. LEETCH said it was very gratifying to those who had to make steel castings to know that people like Mr. Hurst and Mr. Bradshaw were going thoroughly and scientifically into the question of the best type of shot to use; frankly, it was amazingly difficult to get adequate material in this connection for steel castings. It was very difficult also to make a non-smooth surface against a runner. If they could get a shot that was satisfactory from those two standpoints alone a big step forward would be made. On the question of the merits of angular shot and round shot he always felt that the advantage to be obtained from the former was that they were able to get a larger area in contact. With a spherical shot they just got the impact at one point, whereas with an angular shot they were able to hit either the edge or the face. He felt that sand had a more purely abrasive action, whereas with the shot they got an impact action and perhaps a cutting action. Most of the points had been mentioned, but it would appear that if they could get a shot that would work-harden on contact they would be making a further saving of money. So far as nozzles were concerned he had a feeling that the trouble caused by wearing might be overcome by the use of rubber. He felt that the use of rubber for the resistance of abrasion was something that was likely to develop more and more.

MR. HURST said he knew from experience that steel pipes conveying shot from screens into bunkers wore out very rapidly. It was no uncommon thing for a pipe to wear out completely in seven days. Rubber pipes would appear to stand up very much better. He was told that rubber nozzles had been tried, but that the difficulty was to keep them cool. If some means could be devised to keep them cool, rubber nozzles would, he thought, be very satisfactory.

Scale Removal

A MEMBER said he had found that angular shot removed scale from castings quicker than round shot, but his experience was that the loss of angular shot was much greater than the loss of round shot. Angular shot cost about £2 a ton more than round shot, and this was an item that had to be taken into consideration.

Speaking in regard to the question of the size of shot and its effect on scale removal, MR. HURST said he imagined that a great deal would depend on the type of scale. It was, of course, difficult to compare experiments in one works with those carried out in other works, because conditions varied so much. He was interested to hear of the member's experience on the advantage of angular shot over round. There was certainly a difference in price, the round shot being cheaper, but he thought, from his own experience, that the amount of round shot used in cleaning was substantially less than it was a few years ago. Mr. Bradshaw and he (Mr. Hurst) were anxious to know whether there was any real intrinsic value in the angular shot as distinct from the round. It certainly seemed that there was.

Speaking again in the discussion, the MEMBER said he was not sure in his own mind that toughness of shot was an advantage. On the contrary, he felt that it required to be fairly brittle. If they had a shot with sharp edges, they were going to get less effect from it as time went on.

MR. HURST said there might be some confusion of thought as to what toughness was. What he visualised by toughness was measured in terms of energy to break the material, disrupt it and disintegrate it. It was quite possible to have a hard and tough material that would yet not have a tendency to bind over at the edges. He imagined that if they used diamonds, probably the hardest thing that could be imagined, they would not have much success, because of their brittleness.

MR. JAMES TENNENT, managing director of R. B. Tennent, Limited, Whifflet Foundry, Coatbridge, speaking at a recent social gathering of the staff, said that the firm had recently cast the largest steel roll ever made in Great Britain.

British Iron and Steel Corporation

FINANCE FOR PURCHASES

The British Iron and Steel Corporation, Limited, has arranged a mortgage by assignment dated November 22, 1937, to secure advances not exceeding £3,500,000 charged on the benefit of 44 agreements entered into with certain iron and steel producers, under which the said producers agree to pay certain sums to the Corporation; and of any similar agreements entered into by other producers subsequent to the creation of the charge. The holders are Lloyds Bank, Limited, National Provincial Bank, Limited, and Westminster Bank, Limited.

The British Iron and Steel Corporation is the commercial organisation set up by the British Iron and Steel Federation. The Federation, being a non-trading body and having no power to sign contracts, the Corporation has assumed the necessary trading obligations in connection with the purchases, for member iron and steel producers, of tonnages of scrap and pig-iron. And in view of the time lag between purchase by the Corporation and allocation to, and payment by, members, it has been found necessary to come to the above arrangement to provide the Corporation with the necessary working capital. It is emphasised that while the limit of the advances has been fixed at £3,500,000, it does not follow that accommodation approaching that figure will be needed.

World's Output of Pig-Iron and Ferro-Alloys

The subjoined table, which is reproduced from the Statistical Summary (Production, Imports and Exports), 1934-36, issued by the Imperial Institute, shows, in tons of 2,240 lbs., the world's output of pig-iron and ferro-alloys in 1935 and 1936.

Producing country.	1935.	1936.
BRITISH EMPIRE.		
United Kingdom	6,424,100	7,721,400
Union of S. Africa	170,746	198,994
Canada	656,491	752,737
India	1,466,044	1,543,319
Australia†	698,493	*
New Zealand	4,902	—
Total	9,400,000	10,900,000
FOREIGN COUNTRIES.		
Austria	190,119	244,192
Belgium	2,981,752	3,156,752
Czecho-Slovakia	798,130	1,121,883
Finland	10,565	10,861
Saar	297,422‡	—
France	5,698,338	6,131,372
Germany	12,643,316	15,061,443
Hungary	182,947	301,453
Italy	692,718	815,398
Luxemburg	1,842,800	1,955,228
Netherlands	249,610	270,542
Norway	128,686	164,714
Poland	387,873	575,152
Rumania	80,694	95,562
Spain	349,172	276,500
Sweden	602,001	621,231
U.S.S.R.	12,291,700	14,316,300
Yugo-Slavia	21,215	43,751
Mexico	63,126	86,642
United States	21,372,699	31,029,187
Brazil	54,200	76,462
China	*	*
Japan	1,933,579	2,184,002
Korea	241,323	
"Manchoukuo"	598,346	639,548
Philippine Islands	200	200
Total	63,900,000	79,300,000
World's total	73,300,000	90,200,000

* Information not available.

† Years ended June 30.

‡ January-February only, after which date production is included with that of Germany.

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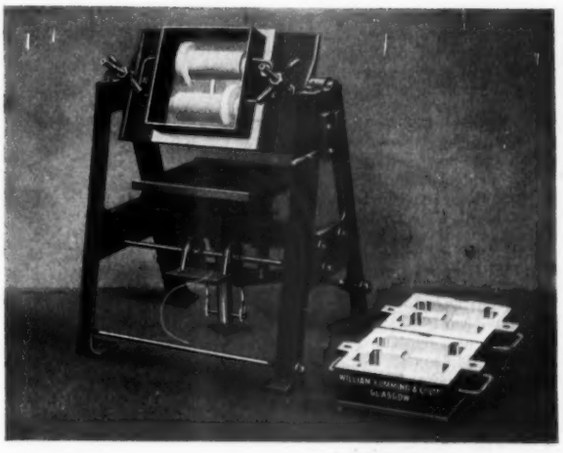

Standard Pattern :

SIZE OF BOX 15 ins. by 15 ins. by 4½ ins.
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Kelvinvale Mills, Maryhill, GLASGOW

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The Week's News in Brief

Trade Talk

BABCOCK & WILCOX, LIMITED, are to erect a works building, foundry stores and test house at their Porterfield Works, Renfrew.

THE SOUTH AFRICAN BRANCH of the Institute of British Foundrymen has decided to inaugurate an annual dinner. This will take place in about April of next year.

ABOUT 800 CHILDREN of employees were entertained at the twenty-fourth annual party given by the directors of Ley's Malleable Castings Company, Limited, Derby, at the works messroom.

A SERIES of sixty lantern-slides illustrating welding repairs to motor cars, commercial vehicles, industrial machinery and other metal parts has been prepared by Barimar, Limited, 14-18, Lamb's Conduit Street, London, W.C.1. These slides, with descriptive text, are available on loan to technical societies, colleges, and similar bodies.

ORDERS PLACED in the United Kingdom by Soviet trading organisations in October amounted to £1,392,544, as compared with £1,114,560 in October, 1936. In the first ten months of this year the value of the orders placed was £18,364,479, against £8,799,505 in the corresponding period of 1936. Orders for machinery and equipment in the ten months totalled £7,955,557; ferrous alloys and steel, £34,564; and non-ferrous metals, £5,142,680.

PARTICULARS have been published recently, for information only, of an issue by the Wolverhampton Die-Castings Company, Limited, of 110,000 6 per cent. cumulative preference shares of 10s. each. The business was founded in 1919 by Messrs. R. and E. G. Whitehead and V. J. West who will continue, as directors, to manage the company, which was formed on December 17. The authorised capital is £130,000 in equal amounts of 6 per cent. cumulative preference shares of 10s. each and 5s. ordinary shares.

THE LAST REPORT of Schneider et Cie (Le Creusot) as an independent manufacturer of armaments, etc., that for the year to April 30 last, has been issued. Under the recent Act nationalising the armaments industry in France, the concern's works passed over to the control of the French Government. It remains in control of the Union Européenne Industrielle et Financiére, which has large interests in mainly Central European armament and other metallurgical undertakings. The accounts are not issued in full detail, but show a net profit of 20,690,000 fcs., against 20,200,000 fcs. in the previous year. A dividend of 80 fcs. per share is to be paid, accounting for a total of 20,000,000 fcs. The capital of the concern is 100,000,000 fcs., and the reserves now total 270,240,000 fcs.

IT IS OFFICIALLY announced that an agreement has been reached between trade-union representatives and officials of non-federated constructional engineering and foundry companies in the Tees-side and Darlington district regulating the wage rates of some 5,000 apprentices and youths. The agreed wage rates are as follow:—Age 14, apprentices 10s. and youths 12s.; 15, 12s. 6d. and 15s.; 16, 15s. and 18s.; 17, 17s. 6d. and 20s.; 18, 21s. and 24s.; 19, 25s and 29s.; 20, 30s. and 34s. The new agreement embodies advances ranging from 2s. to 7s. per week, and it is expressly stipulated that any youth or apprentice now being paid in excess of the scale shall not suffer a reduction. Provision is also made for the variation of the scale either upward or downward, according to the rise and fall of the wages of adults.

Obituary

MR. J. E. COMPTON-BRACEBRIDGE, for many years a partner in the firm of Easton & Anderson, engineers, of Atherstone, has died, aged 78.

THE DEATH has occurred of Mr. William Gray, who was in employment at the Lion Foundry, Kirkintilloch, for over half a century. He was chief clerk for many years.

MR. JOHN COLLETT MOULDEN, a director of Baronia Metals, Limited, Evertite Locknuts, Limited, Nuts & Bolts (Darlaston), Limited, and the Tungsten Manufacturing Company, Limited, has died at the age of 64. He was an associate of the Royal School of Mines and a member of the Institution of Mining and Metallurgy.

Personal

MR. J. F. SCHUBELER, managing director of Sulzer Bros. (London), Limited, engineers, is resigning from the board at the end of the year. Mr. R. M. Atkinson is to succeed him.

PROVOST BEGG has been presented with a travelling case, and Mr. James Fraser with a gold watch, by the members of the General Ironfitters' Association, in recognition of their services to the union.

MR. W. KILLINGBECK (commercial manager and secretary) and Mr. J. W. Danks (general works manager) have been appointed local directors of the Barrow Hematite Steel Company, Limited. Mr. F. E. Parr (London manager) has been appointed local director for the London area.

Wills

WOLVERSON, H., of Willenhall, Staffs, ironfounder	£5,165
DEWRANCE, SIR JOHN, head of Dewrance & Company, engineers, and late chairman of Babcock & Wilcox, Limited, boiler makers	£392,609

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Engineering & Metals Company, Limited, Thames House, Millbank, London, S.W.1.—Capital £10,000.

Commercial Metal Company, Limited.—Capital £30,000. Subscriber: J. Simon, 37, Grosvenor House, Park Lane, London, W.1.

Smith & Fawcett, Limited.—Capital £25,000. Ironfounders, steelmakers, etc. Directors: J. Fawcett and N. Smith, Horton Ironworks, Lidget Green, Bradford.

Company Meeting

Presiding at the annual meeting of R. A. Lister & Company, Limited, held at Dursley, on December 17, MR. PERCY LISTER (chairman) said that their turnover for the year was again a record in the history of the company, and this was the more satisfactory because the increased volume had been spread over the entire range of the products made by the company, and the demand had shown an increase not only in the domestic market, but in all the principal overseas markets. The trading results for the first full financial year of their subsidiary company, Blackstone & Company, Limited, of Stamford, had been substantially improved. The new foundry at Dursley was now nearing completion.

Company Report

Cannon Iron Foundries, Limited.—Net profit for year ended September 30, after depreciation and reserve against securities, £52,956; brought in, £10,959; income tax and N.D.C., £18,393; final dividend on the ordinary shares of 5 per cent., making 10 per cent. for the year, £9,375; to general reserve, £5,000; to reserve for taxation, £2,500; carried forward, £10,988. Meeting, December 31.

Catalogue Received

Electric Support Grinding Machine. This machine, which is described in a new publication just issued by the firm of F. H. Ockenfels, of Mill Street, Slough, Bucks, is really an attachment. It can be made to work in conjunction with a lathe, planer or shaping machines, the attachment supplying both the grinding and dust-collecting mechanism. It is just the type of plant which can be of infinite use in the smaller type of machine-shop undertaking jobbing work.

Metallography and Mechanical Properties of Brass Cast Under Pressure

P. N. POYAKOV, writing in "Liteinoe Delo," No. 7, 1937, states that in the case of brass cast under normal conditions, the alpha phase alone occurs for zinc contents of up to 39 per cent. Upon increasing the zinc content to 46 per cent. the alpha and beta components occur together. In chill cast brass, the beta component may be obtained with a zinc content of the brass as low as 33.5 per cent., while in the case of brass cast under pressure, a structure exhibiting both phases is observed with zinc contents of 26 per cent. or less. The crust on specimens cast under pressure is found to consist mainly of the beta phase, another characteristic feature being the orientation of the alpha crystals, which are observed to lie perpendicularly to the surface of the chill.

The predominance of alpha crystals in the ground-mass of the casting is the cause of the low tensile strength and high extensibility of specimens from which the crust has been removed. Increasing the casting temperature of the metal results in a decrease in the amount of alpha component and a slight increase in the mechanical properties.

The temperature of the mould has a considerable influence, other factors remaining the same. With increase in the temperature of the mould, the alpha crystals increase in size and the mechanical properties are impaired. Annealing of the casting may be of practical importance in some cases, but an excessive annealing temperature again causes an increase in the alpha component with a corresponding reduction in the mechanical properties.

The effect of additions of aluminium, tin, lead and iron has also been investigated. An addition of tin of up to 1.14 per cent. is accompanied by an increase in the tensile strength, the elongation remaining practically the same. An increase in the lead content from 0.94 to 2.18 per cent. does not result in any appreciable change in the mechanical properties. Increasing the iron content up to 0.44 per cent. produces an increase in the tensile strength without any appreciable change in the elongation. Further increase in the iron content up to 0.88 per cent. diminishes the mechanical properties of the brass. Aluminium has no effect up to a content of 0.25 per cent., but further increase causes the casting to become excessively brittle.

Publication Received

The Head Wrightson Bulletin, No. 7. Published quarterly from the Teesdale Iron Works, Thornaby-on-Tees.

This is the first number which has come into our possession, and it probably better represents the average issue than would have the first. Taking this for granted, we think it approaches the ideal. It is not being run at the expense of the firm's suppliers as apparently is the case with certain house organs. It is informative of their own activities, or, better still, their manufacturing potentialities. In this issue short descriptions of the foundries are included. Here we suggest that some details of the production of the individual foundries might have been included. The total capacity of all the plants is of the order of 100,000 tons per annum, a figure approximating the total output of some of the minor manufacturing countries of Europe.

MR. J. B. MAVOR, managing director of Mavor & Coulson, Limited, has been elected vice-president of the North-West Engineering Trades Employers' Association.

TOR ROCK SAND
for the
FOUNDRY

Higher casting temperatures in iron foundries—particularly in those where special alloys are melted—have resulted in a demand for a moulding sand to withstand severe conditions and produce sound castings of good finish. Tor Rock Sand has proved to be specially suitable for these requirements. It is coarse in grain and highly permeable and being somewhat irregularly graded, tends to give a strong and compact mould surface.

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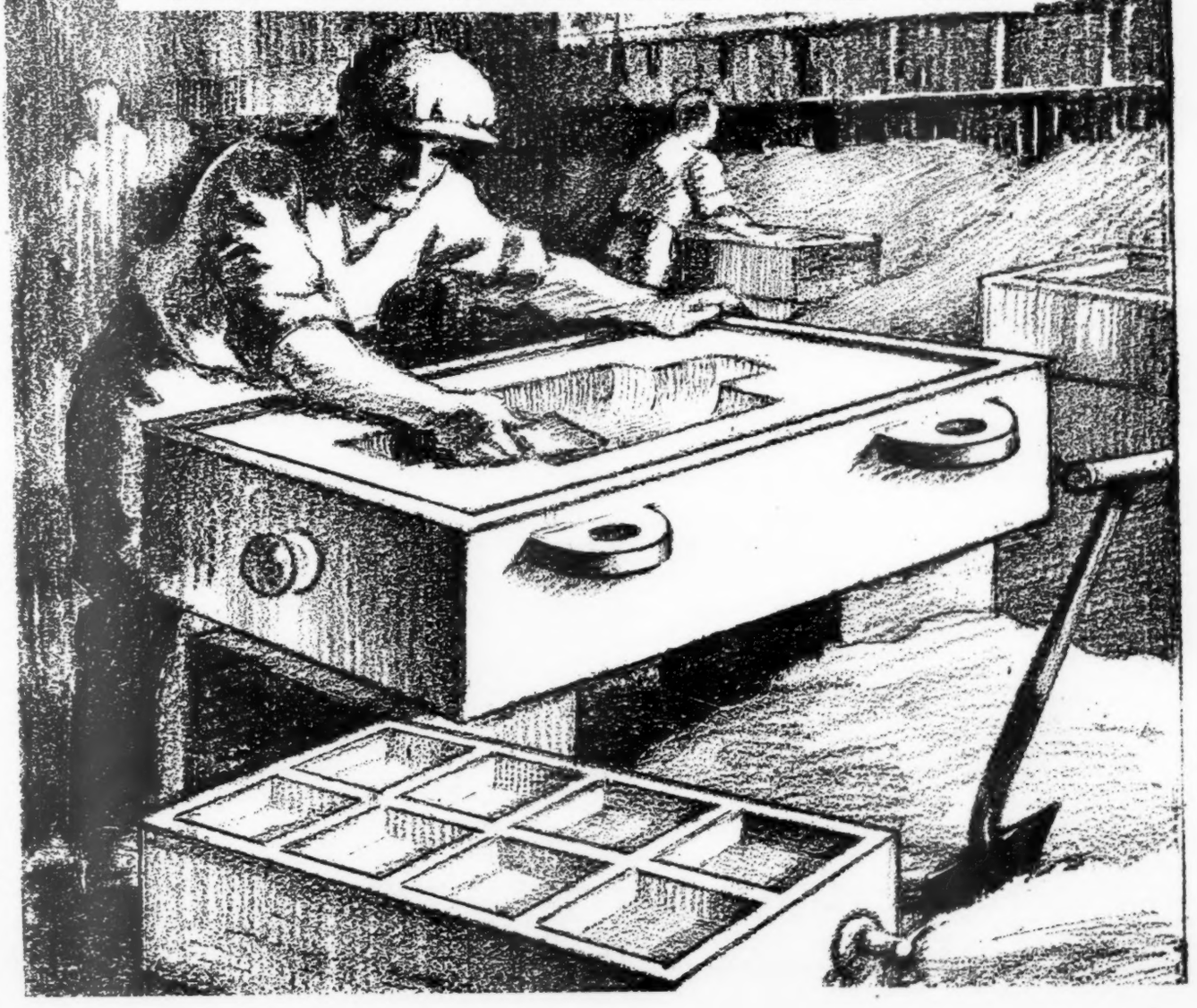
SWANSEA OFFICE: Metropole Chambers, Wind Street. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).

MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130. Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs, Exchange Place. Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place. Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).



Raw Material Markets

Holidays at the iron and steel works in most areas have been curtailed to a minimum or dispensed with altogether. In some cases slightly longer periods have been taken in order to carry out essential repairs. Outputs over the first half of 1938 are for the most part under requisition. New business at present is not substantial. Prices are stabilised, and consumers are unwilling to book very far ahead, while makers, for their part, are reluctant to add to their already well-filled order-books.

Pig-Iron

MIDDLESBROUGH.—It is fortunate for consumers in this area that supplies of Midland foundry iron are available in fairly good tonnages, as delivery arrears of Cleveland iron are substantial. For delivery on the North-East Coast and in Falkirk over the first half of the year, No. 3 Cleveland G.M.B. is quoted at 109s., with deliveries elsewhere on the North-East Coast at 111s., and on Clydeside at 112s. per ton, less 5s. rebate. The hematite market remains very firm and full outputs are going immediately into consumption. In order to retain contact with overseas consumers, moderate shipments are being despatched, but this section is inevitably restricted. For delivery on the North-East Coast after December 31, East Coast mixed numbers will be quoted at 132s. 6d., 138s. in the Sheffield area and 143s. 6d. in the Midlands.

LANCASHIRE.—Owing to substantial delivery arrears, furnaces welcomed the holiday, as they were able to improve their position to some extent, most of the consuming plants being closed for a few days. For delivery in the Lancashire price zone, Derbyshire, Staffordshire and Lancashire qualities of No. 3 foundry iron are quoted on the basis of 114s., with Northamptonshire at 112s. 6d. Order-books for hematite are well filled. Deliveries generally are fairly satisfactory. West Coast hematite is quoted on the basis of 141s., delivered in the Manchester district, and East Coast at 140s. 6d. These prices are valid over the first half of 1938.

MIDLANDS.—Conditions in the pig-iron market in this area are undoubtedly easier than in any other district. In some cases makers are building up quite useful stocks, while supplies are being despatched to other areas in order to relieve the shortage. Generally, however, consumers' requirements are sufficient to ensure that current output is well taken up and an expansion at some of the plants which have been less active recently is expected early in the New Year. For delivery to Birmingham and Black Country stations, Northants No. 3 iron is quoted at £5 8s. 6d., and Derbyshire No. 3 at £5 11s., less 5s. rebate. Low-phosphorus iron is in good request at prices ranging from £6 7s. 6d. to £7 10s. Refined iron is quoted at a minimum of £8 5s. For delivery after December 31, East Coast No. 3 iron will be quoted at £7 3s. 6d., with West Coast mixed numbers at £7 4s. 6d., less 5s. rebate. Scottish No. 3 is around £7 per ton, but supplies are scarce, and the price is too high to attract much business.

SCOTLAND.—While new business is not very active at the present time, producers are well supplied with orders over the early part of the New Year. Loss of time has recently been encountered owing to the carrying out of essential repairs, but the holidays were made as short as possible. Scottish No. 3 foundry is quoted at 118s. f.o.t. furnaces, with No. 1 at 120s. 6d. No. 3 Cleveland is at 109s. f.o.t. Falkirk and 112s. f.o.t. Glasgow, less 5s. rebate. Local steelworks are working to capacity. Hematite mixed numbers are at 133s., Scottish basic at 107s. 6d. and English and Indian basic at 100s., f.o.t. steelworks, and less 5s. per ton rebate.

Coke

For delivery in Birmingham and district, best Durham coke is quoted at a minimum of 55s. 9d., with Welsh coke at from 55s. to 65s., according to quality. New business is quiet, as most consumers have covered their requirements up to the end of the winter, which is as far as they are disposed to go at the present time.

Steel

There is little change to report in the steel market. Owing to holiday interruptions new business has been quiet, while little expansion can be expected for a few weeks, as most works will be occupied with stocktaking. The steelworks have been working to full capacity for a long time past, and consequently repairs have become necessary. Apart from this, however, as little time as possible was lost at the holidays.

Scrap

The iron and steel scrap market remains quite firm and buyers are keen to procure substantial supplies. Sellers are unwilling to dispose of heavy tonnages at the present time, as they are already well sold forward. Business is restricted now by the stocktaking operations which are inevitable at the end of the year.

Metals

The London Metal Exchange was closed after the morning session on Friday until Tuesday morning. Holidays and stocktaking have caused the markets to be even quieter than they have recently been. The lead market has proved rather an exception, and some quite good tonnages have changed hands.

Copper.—The market remained quiet right up to the holidays and business has been very dull since. Confidence is lacking and there appears to be little likelihood of any material expansion of buying in the near future. Industrial activity is less satisfactory, for which seasonal influences must be held responsible to some extent. The feature of the United States market is the heavy buying by Japan; apart from this, the market remains dull and uninteresting.

Metal Exchange quotations were as follow :—

Cash.—Wednesday, £40 7s. 6d. to £40 8s. 9d.; Thursday, £39 17s. 6d. to £39 18s. 9d.; Friday, £39 18s. 9d. to £40; Tuesday, £39 6s. 3d. to £39 7s. 6d.; Wednesday, £38 17s. 6d. to £39.

Three Months.—Wednesday, £40 12s. 6d. to £40 13s. 9d.; Thursday, £40 2s. 6d. to £40 3s. 9d.; Friday, £40 3s. 9d. to £40 5s.; Tuesday, £39 10s. to £39 12s. 6d.; Wednesday, £39 1s. 3d. to £39 3s. 9d.

Tin.—The December issue of the Statistical Bulletin issued by the International Tin Research and Development Council indicates that world tin production in October was 16,500 tons, against 19,200 tons in the preceding month and 16,900 tons in October of last year. In the year ended October, 1937, tin production amounted to 197,500 tons, against 174,600 tons in the preceding year. World apparent consumption was 16,500 tons in October, against 14,400 tons in the preceding month and 12,900 tons in October of last year. In the year ended October, 1937, consumption amounted to 180,500 tons, as compared with 159,100 tons in the preceding year. World tinplate production in October amounted to 296,000 tons, against 371,000 tons in the preceding month and 340,000 tons in October of last year. The consumption of tin in this industry was 4,800 tons in October, 1937, against 5,700 tons in October, 1936. During November, 1937, visible stocks increased by about 1,500 tons to 23,327 tons, representing 12.9 per cent. of the current annual rate of consumption.

Speaking at the recent meeting of Southern Malayan Tin Dredging, Mr. C. V. Stephens (chairman) said he hoped that the International Tin Committee would decide to proceed with the formation of a buffer stock scheme with a view to establishing some form of price control. He believes that such a stabilising influence would go far to remove the ills inherent in the violent price fluctuations which accompanied the present method, by which the great majority of the producers were obliged to dispose of their tin without let or hindrance in regard to the price. With regard to the future, the indications pointed to a healthy market demand as likely to continue in this country and on the Continent for some time ahead.

It has been suggested in tin circles that the introduction of a buffer pool is a likely possibility for the New Year. The Buffer Pool Sub-Committee of the International Tin Committee met in London on the day previous to the last meeting of the full Committee.

Official quotations were as follow :—

Cash.—Wednesday, £189 2s. 6d. to £189 7s. 6d.; Thursday, £187 2s. 6d. to £187 7s. 6d.; Friday, £186 5s. to £186 7s. 6d.; Tuesday, £183 to £183 5s.; Wednesday, £181 to £181 10s.

Three Months.—Wednesday, £188 15s. to £189; Thursday, £186 15s. to £187; Friday, £185 15s. to £186; Tuesday, £182 10s. to £183; Wednesday, £181 to £181 5s.

Spelter.—While the political outlook remains so obscure, it is difficult to see very far ahead. The weekly market report issued by Rudolf Wolff & Company states that demand on the part of consumers has been quiet, but the comparatively low price to which this metal has fallen in the last few months offers little incentive to sellers, and at the same time attracts buying on a moderate scale. On the Continent, the market is reported quiet and unchanged. Pending fresh developments, steady conditions seem likely to prevail.

Daily market prices :—

Ordinary.—Wednesday, £15 7s. 6d.; Thursday, £14 18s. 9d.; Friday, £15 2s. 6d.; Tuesday, £15 1s. 3d.; Wednesday, £14 17s. 6d.

Lead.—Considering the holiday interruptions and other seasonal influences, this market has been well supported. The outlook appears to be quite satisfactory. Official returns reveal that there was a further decline last month in the estimated cost of buildings for which plans have been approved. Returns from 141 local authorities present a total of £7,811,600, representing a decrease of £1,223,700, or 13.5 per cent., on the figure for November, 1936. For the eleven months the total of about £100,300,000 is £7,700,000 below that of the same period of 1936.

Day-to-day quotations :—

Soft Foreign (Prompt).—Wednesday, £15 12s. 6d.; Thursday, £15 12s. 6d.; Friday, £15 12s. 6d.; Tuesday, £15 12s. 6d.; Wednesday, £15 10s.

Scrap.—Both buyers and sellers are showing reserve in this section of the non-ferrous metal market, and business has again been slow to materialise. Higher prices for new metal would have the effect of raising scrap prices, which is the hope of sellers at the present time. With the exception of a small increase in the price of scrap lead, quotations are about unchanged on the week.

Approximate selling prices for old metal :—New aluminium cuttings, £82; rolled, £67; cast, £40; foil, £94 to £98. Copper, £37 to £41; braziery, £36. Brass (clean), £24 to £26. Zinc, £9. Lead, £15 5s. Gunmetal, £39 to £40.

Applications for Trade Marks

The following list of applications to register trade marks has been taken from the "Trade Marks Journal" :—

"JOFO" (DEVICE).—Stainless-steel goods. H. Johnson Foster, Limited, Trent Street, Sheffield, 9.

"DAVY-UNITED."—Forging presses, rolling-mill machinery, steelworks machinery, hydraulic machinery, and boilers. Davy & United Engineering Company, Limited, Park Ironworks, Sheffield.

"ELKONITE," "ELKALOY" AND "ELKON."—Metals. Mallory Metallurgical Products, Limited, No. 1, North Section, Waddon Factory Estate, Croydon, Surrey.

"UNIFA."—Welding machines and parts of welding machines. A Arc, Limited, 52A, Goldhawk Road, London, W.12.

"THERMOFEED."—Apparatus for controlling automatically the quantity of feed liquid supplied to steam boilers, etc. Ronald Trist & Company, Limited, 1-3, Brixton Road, London, S.W.9.

Tin Estimation with Dithiol

"Dithiol" is now available commercially as the toluene-3:4-dithiol, and Clark's method for the colorimetric determination of tin has conveniently been modified to enable this reagent to be used instead of the substituted benzene dithiols originally used. Full details of the new procedure, which should certainly interest all metallurgists controlling foundry laboratories, are given in Technical Publication, Series A, Number 69, of the International Tin Research and Development Council, 378, Strand, London, W.C.2, from whom copies may be obtained free of charge.

"TITAN"

Low Phosphorus
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ALL-MINE PIG IRON

G. & R. THOMAS LTD.

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RAW MATERIALS—PRICE LIST

(Wednesday, December 29, 1937)

COPPER

	£	s.	d.
Standard cash	38	17	6
Three months	39	1	3
Electrolytic	42	0	0
Tough	42	5	0
Best selected	42	15	0
Sheets	74	0	0
India	53	5	0
Wire bars	44	0	0
Ingot bars	44	0	0
H.C. Wire rods	47	10	0
Off. av. cash, Nov.	39	7	$4\frac{7}{11}$
Do., 3 mths., Nov.	39	13	$0\frac{3}{22}$
Do., Sttlmnt., Nov.	39	7	$7\frac{4}{11}$
Do., Electro, Nov.	44	18	$7\frac{7}{11}$
Do., B.S., Nov.	44	19	$8\frac{8}{11}$
Do., Wire bars, Nov.	45	16	$9\frac{9}{11}$
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8¼d.

BRASS

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	9½d.
Rods, extd. or rlld.	6¾d.
Sheets to 10 w.g.	8¼d.
Wire	8¾d.
Rolled metal	8¼d.
Yellow metal rods	6¾d.

TIN

	£	s.	d.
Standard cash	181	0	0
Three months	181	0	0
English	181	0	0
Bars	183	0	0
Straits	185	0	0
Eastern	179	15	0
Banca (nom.)			—
Off. av. cash, Nov.	190	13	$7\frac{7}{11}$
Do., 3 mths., Nov.	190	5	$1\frac{4}{11}$
Do., Sttlmt., Nov.	190	14	$3\frac{9}{11}$

SPELTER

	£	s.	d.
Ordinary	14	17	6
Remelted	12	10	0
Hard	11	15	0
Electro, 99.9	18	11	3
English	16	5	0
India	15	0	0
Zinc dust	23	15	0
Zinc ashes	6	0	0
Off. aver., Nov.	15	17	$9\frac{9}{22}$
Aver., spot, Nov.	15	16	$1\frac{13}{44}$

LEAD

	£	s.	d.
Soft foreign, ppt.	15	10	0
Empire (nom.)	16	10	0
English	17	10	0
Off. aver., Nov.	16	14	$2\frac{5}{11}$
Aver. spot, Nov.	16	14	$1\frac{19}{44}$

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

Zinc sheets, English	29	0	0 to 29	10	0	
Do., V.M. ex-whse.	29	0	0 to 29	10	0	
Rods			23	0	0	

ANTIMONY

English	81	0	0 to 82	0	0	
Chinese, ex-whse. (nom.)			64	0	0	
Crude, o.i.f.			37	0	0	

QUICKSILVER

Quicksilver	13	0	3	

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—					
25%	14	10	0		
45/50%	12	0	0		
75%	17	0	0		
Ferro-vanadium 35/50%	12/8			lb.	Va.
Ferro-molybdenum— 70/75% carbon-free	4/9			lb.	Mo.
Ferro-titanium— 20/25% carbon-free					9d. lb.
Ferro-phosphorus, 20/25%	£21 to £22				
Ferro-tungsten— 80/85%					9/3 lb.
Tungsten metal powder— 98/99%					9/6 lb.
Ferro-chrome— 2/4% car.	34	15	0		
4/6% car.	24	5	0		
6/8% car.	24	0	0		
8/10% car.	24	0	0		
Ferro-chrome— Max. 2% car.	36	0	0		
Max. 1% car.	38	5	0		
Max. 0.5% car.	41	0	0		
70% carbon-free					10d. lb.
Nickel—99.5/100%	£180 to £185				
"F" nickel shot	£165	0	0		
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.				
Metallic chromium— 96/98%					2/5 lb.
Ferro-manganese— 76/80% loose	£18	15	0 to 19	5	0
76/80% packed	£19	15	0 to 20	5	0
76/80% exnort			£22	0	0
Metallic manganese— 94/96% carbon-free					1/3 lb.

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 10d.
Finished bars, 18% tungsten	5s. 0d.

Per lb. d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ¼ in. to ⅛ in.	3d. lb.
Do., under ⅛ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ¼ in. × ⅛ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ⅛ in. × ⅛ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.	£	s.	d.
South Wales (West)— Heavy steel, best	3	8	9 to 3	11	3	
Mixed iron and steel	3	6	9 to 3	9	3	
Heavy cast iron	3	8	9 to 3	11	3	
Good machinery				3	17	6
Cleveland— Heavy steel, best	3	7	0 to 3	9	6	
Steel turnings	2	13	0 to 2	15	6	
Heavy cast iron				4	5	0
Heavy machinery				4	10	0
Midlands— Short heavy steel				4	0	0
Light cast-iron scrap				3	2	6
Heavy wrought iron	4	0	0 to 4	5	0	
Steel turnings	2	6	3 to 2	8	9	
Scotland— Heavy steel, best	3	5	0 to 3	7	6	
Ordinary cast iron	4	5	0 to 4	7	6	
Cast-iron borings	2	0	0 to 2	2	6	
Wrot-iron piling				4	17	6
Heavy machinery	4	10	0 to 4	12	6	

London—Merchants' buying prices, delivered yard.

Copper (clean)	33	0	0
Brass	23	10	0
Lead (less usual draft)	14	0	0
Tea lead	11	10	0
Zinc	8	10	0
New aluminium cuttings	71	0	0
Braziery copper	30	0	0
Gunmetal	33	0	0
Hollow pewter	135	0	0
Shaped black pewter	100	0	0

PIG-IRON*

N.E. Coast (d/d Tees-side area)—

Foundry No. 1	111/6
,, No. 3	109/-
,, No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6

N.W. Coast—

Hem. M/Nos. d/d Glas.	133/-
,, d/d Birm.	144/6
Malleable iron d/d Birm.	160/5

Midlands (d/d Birmingham dist.)—

Staffs No. 4 forge	110/-
,, No. 3 fdry.	111/-
Northants forge	107/6
,, fdry. No. 3	108/6
,, fdry. No. 1	111/6
Derbyshire forge	110/-
,, fdry. No. 3	111/-
,, fdry. No. 1	114/-

Scotland—

Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
,, ,, Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-

Sheffield (d/d district)—

Derby forge	107/6
,, fdry. No. 3	108/6
Lincs forge	107/6
,, fdry. No. 3	108/6
W.C. hematite	138/6

Lancashire (d/d eq. Man.)—

Derby fdry, No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	141/-
Clyde, No. 3	141/-
Monkland, No. 3	141/-
Summerlee, No. 3	141/-
Eglinton, No. 3	141/-
Gartsherrie, No. 3	141/-
Shotts, No. 3	141/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	13	5	0 to 13	15	0	
Nut and bolt iron	11	12	6 to 12	2	6	
Hoops				14	2	6
Marked bars (Staffs) f.o.t.				15	15	0
Gas strip				14	2	6
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up
Steel— Plates, ship, etc.	11	8	0 to 11	10	6	
Boiler plts.	11	18	0 to 12	0	6	
Chequer plts.				13	0	6
Angles				11	0	6
Tees				12	0	6
Joists				11	0	6
Rounds and squares, 3 in. to 5½ in.				12	0	6
Rounds under 3 in. to ¾ in. (Untested)				11	9	0
Flats—8 in. wide and over				11	5	6
,, under 8 in. and over 5 in.				11	10	6
Rails, heavy				10	2	6
Fishplates				14	2	6
Hoops (Staffs)				12	4	0
Black sheets, 24g. (4-t. lots)				15	15	0
Galv. cor. shts. (,,)				18	10	0
Galv. flat shts. (,,)				19	0	0
Galv. fencing wire, 8g. plain				20	5	0
Billets, soft, 100-ton lots				7	17	6
Sheet bars				7	15	0
Tin bars				7	15	0

PHOSPHOR BRONZE

	Per lb. basis
Strip	11d.
Sheet to 10 w.g.	11½d.
Wire	12⅝d.
Rods	13½d.
Tubes	18½d.
Castings	15½d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled— To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	8d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round— to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.76
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	38/6
,, furnace	37/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	22/6 to 23/-	
,,	28×20 ,,	45/- to 46/-	
,,	20×10 ,,	35/- to 35/6	
,,	18¾×14 ,,	25/- to 25/6	
C.W.	20×14 ,,	19/6 to 20/-	
,,	28×20 ,,	39/- to 40/-	
,,	20×10 ,,	30/6 to 31/-	
,,	18¾×14 ,,	21/6 to 22/-	

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12	0	0 to £13	0	0	
Bars-hammered, basis	£20	0	0 to £22	0	0	
Bars and nail-rods, rolled, basis	£19	0	0 to £20	0	0	
Blooms	£18	0	0 to £19	0	0	
Keg steel	£30	0	0 to £35	0	0	
Faggot steel	£20	0	0 to £25	0	0	
Bars and rods dead soft st'l	£19	0	0 to £20	0	0	

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£ s. d.	
Dec.	22 ..	40 7 6 dec.	2/6
,,	23 ..	39 17 6 ,,	10/-
,,	24 ..	39 18 9 inc.	1 3
,,	28 ..	39 6 3 dec.	12 6
,,	29 ..	38 17 6 ,,	8/9

Standard Tin (cash)

		£ s. d.	
Dec.	22 ..	189 2 6 inc.	12/6
,,	23 ..	187 2 6 dec.	40/-
,,	24 ..	186 5 0 ,,	17/6
,,	28 ..	183 0 0 ,,	65/-
,,	29 ..	181 0 0 ,,	40/-

Spelter (ordinary)

		£ s. d.	
Dec.	22 ..	15 7 6 dec.	1/3
,,	23 ..	14 18 9 ,,	8/9
,,	24 ..	15 2 6 inc.	3/9
,,	28 ..	15 1 3 dec.	1/3
,,	29 ..	14 17 6 ,,	3/9

Lead (soft foreign, prompt)

		£ s. d.	
Dec.	22 ..	15 12 6 dec.	2/6
,,	23 ..	15 12 6 No	change
,,	24 ..	15 12 6 ,,	,,
,,	28 ..	15 12 6 ,,	,,
,,	29 ..	15 10 0 dec.	2/6

Electrolytic Copper

		£ s. d.	
Dec.	22 ..	44 0 0 No	change
,,	23 ..	44 0 0 ,,	,,
,,	24 ..	44 0 0 ,,	,,
,,	28 ..	43 0 0 dec.	20/-
,,	29 ..	42 0 0 ,,	20/-

Tin (English ingots)

		£ s. d.	
Dec.	22 ..	189 2 6 inc.	12/6
,,	23 ..	187 2 6 dec.	40/-
,,	24 ..	186 5 0 ,,	17/6
,,	28 ..	183 0 0 ,,	65/-
,,	29 ..	181 0 0 ,,	40/-

Spelter (Electro, 99.9 per cent.)

		£ s. d.	
Dec.	22 ..	19 1 3 inc.	2/6
,,	23 ..	18 13 9 dec.	7/6
,,	24 ..	18 16 3 inc.	2/6
,,	28 ..	18 15 0 dec.	1/3
,,	29 ..	18 11 3 ,,	3/9

Lead (English)

		£ s. d.	
Dec.	22 ..	17 15 0 No	change
,,	23 ..	17 15 0 ,,	,,
,,	24 ..	17 15 0 ,,	,,
,,	28 ..	17 15 0 ,,	,,
,,	29 ..	17 10 0 dec.	5/-

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1901	2 13 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 16 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 14 0	2 16 6	3 0 0	3 0 0	2 14 1	
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 1' 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 16 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1933	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0
1934	3 7 0	3 9 6	3 13 2½	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 12 11½
1935	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 14 0	3 18 0	3 14 8
1936	3 18 0	3 18 0	3 18 0	3 18 0	3 18 0	3 18 0	4 3 0	4 3 0	4 3 0	4 3 0	4 3 0	4 9 0	4 1 0
1937	4 9 0	4 9 0	4 9 0	4 9 0	4 9 0	4 9 0	5 9 0	5 9 0	5 9 0	5 9 0	5 14 0	5 14 0	4 19 10

NOTE: Prices have been subject to a rebate of 5/- per ton since November 1, 1937. * No prices available during strike period.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

ASSISTANT Foundry Manager requires change. Light grey-iron castings for vitreous enamelling. Practical man with good technical qualifications.—Box 718, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY Manager (33), 17 years' experience (principally non-ferrous), 9 years executive control, seeks situation in any district. Sound technical knowledge and commercial experience. Excellent references. Disengaged.—Box 722, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOREMAN Coremaker wanted, used to quick production of good quality small and medium cores. Permanent post and good wage plus bonus. Reply giving age, experience, and wage expected to: Box 704, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

LARGE mining company requires services of competent Metallurgist as Superintendent of sintering plant abroad. Must have recognised technical education and practical metallurgical training, together with experience in sintering iron ores and similar materials. Liberal salary and leave, and permanent employment for suitable man. Age limit 40 years. Write full particulars and copy testimonials to: "N.C.," c/o J. W. VICKERS & Co., LTD., 24, Austin Friars, E.C.2.

WANTED.—Moulder to take charge of small foundry using Armstrong-Whitworth oil furnace, and moulding machines. Must be used to the mass production of small iron castings.—Box 720, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

FOUNDRY Foreman with thoroughly practical training and experience requires re-engagement. Experience includes general engineering castings up to 20 tons, also repetition work, machine and plate (315)

FOUNDRY or Works Manager. Position required by young man with considerable experience as Manager and Superintendent, including non-ferrous work. Modern production and costing methods. (316)

YOUNG Foundry Manager desires change. Several years' experience as manager on general engineering, small and medium castings, including machine and plate moulding. Up-to-date cupola practice. (317)

FOREMAN or Assistant Foundry Foreman requires re-engagement. Had experience in both capacities, on general engineering and jobbing work. Good knowledge of cupola practice. (318)

AGENCY

AGENT for sale of high class grey-iron castings in Yorkshire wanted by Staffordshire Ironfoundry. Good prospects. State age and proposed terms and details of experience to: Box 724, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MACHINERY

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & Co., LTD., Station Works, Ecclesfield, Sheffield.

ELECTRIC CUPOLA BLOWERS (large stock), including two 50-h.p. 3/50/400 volts, 2,900 r.p.m.; Keith Blackman; 12-in. outlet.
30-h.p. ditto; 12-in. outlet.
5-h.p. ditto; 6-in. outlet.
20-h.p. 460 volts d.c., 2,400/1,900 r.p.m.; 10-in. outlet.
EXHAUST FANS (large stock), electrical and belt driven.
ELECTRIC RUNWAY LIFTING BLOCKS:
One 4½-ton 460 volts d.c., Vaughan.
Two 2-ton ditto, Morris.
One ½-ton 220 volts d.c., Morris (as new).
One ½-ton 3/50/440 volts, Aabacas.
Two Reavell Rotary Compressors, 12 lbs. sq. in. pressure; 750 cub. ft. direct-coupled on bedplate to 60 h.p. S.R., 3/50/400 volts motor.
½-cwt. Pilkington Self-contained Pneumatic Hammer.
Geared Foundry Ladles, 9, 4, 3½, 2½ and 1 ton, etc.
AIR COMPRESSORS: 30 in stock in sizes 500 to 20 cub. ft.
ELECTRIC MOTORS: Large stock to suit almost all electric systems.

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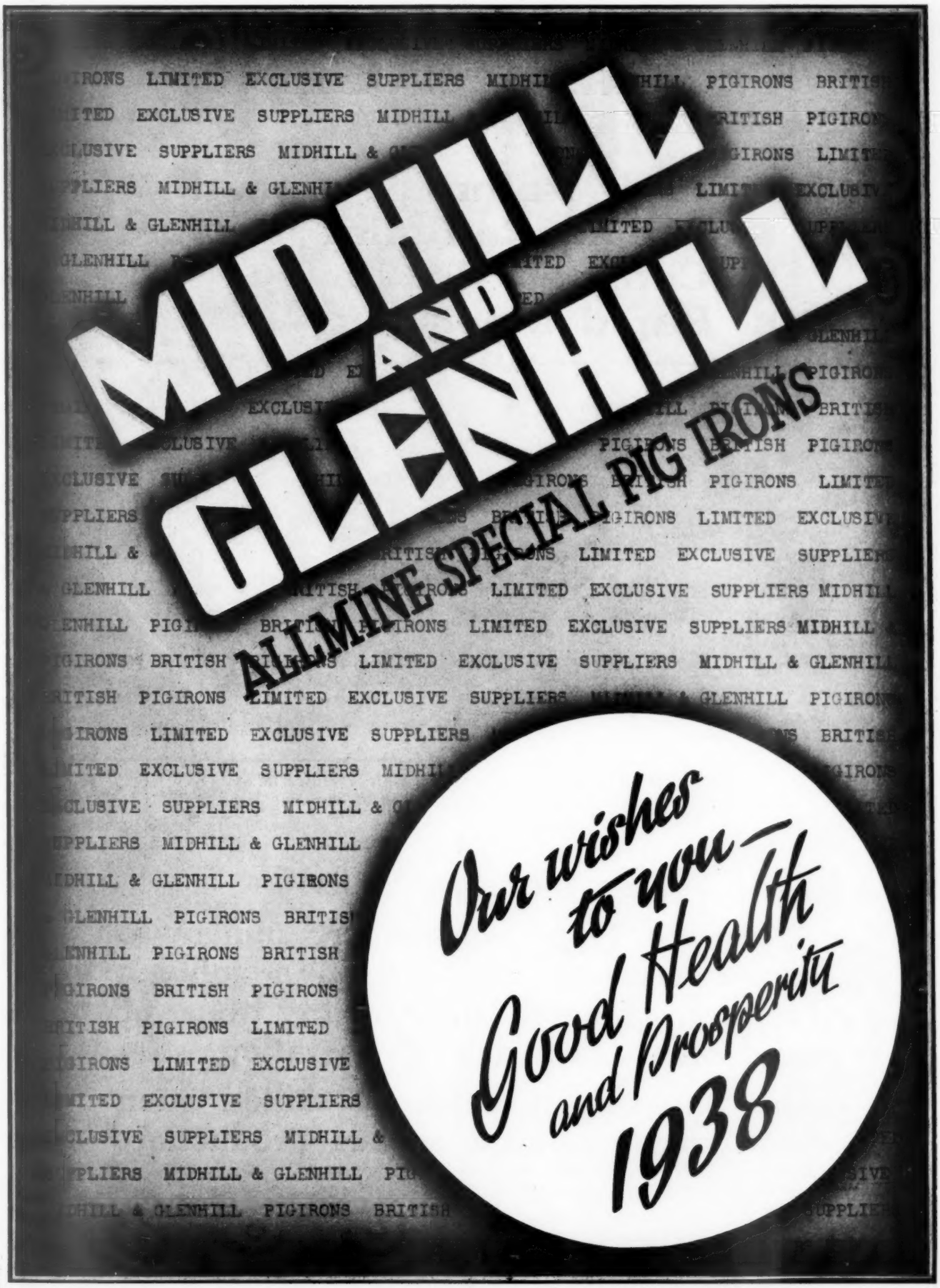

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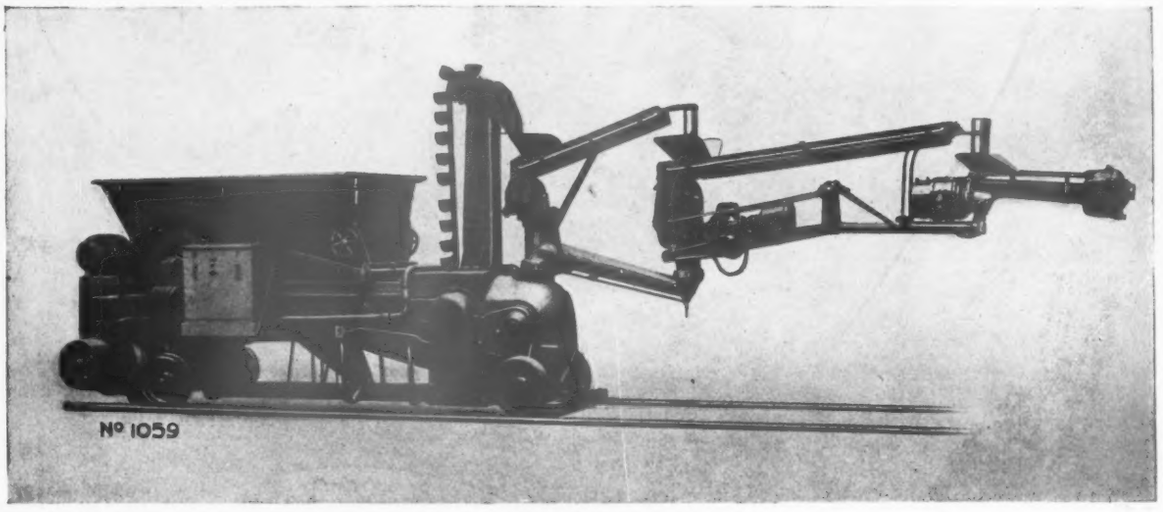

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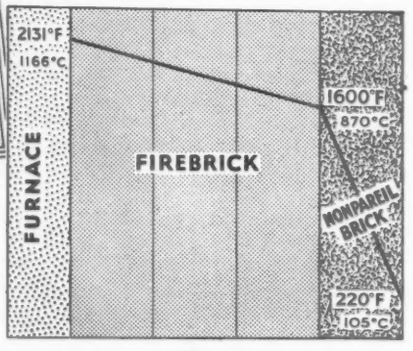

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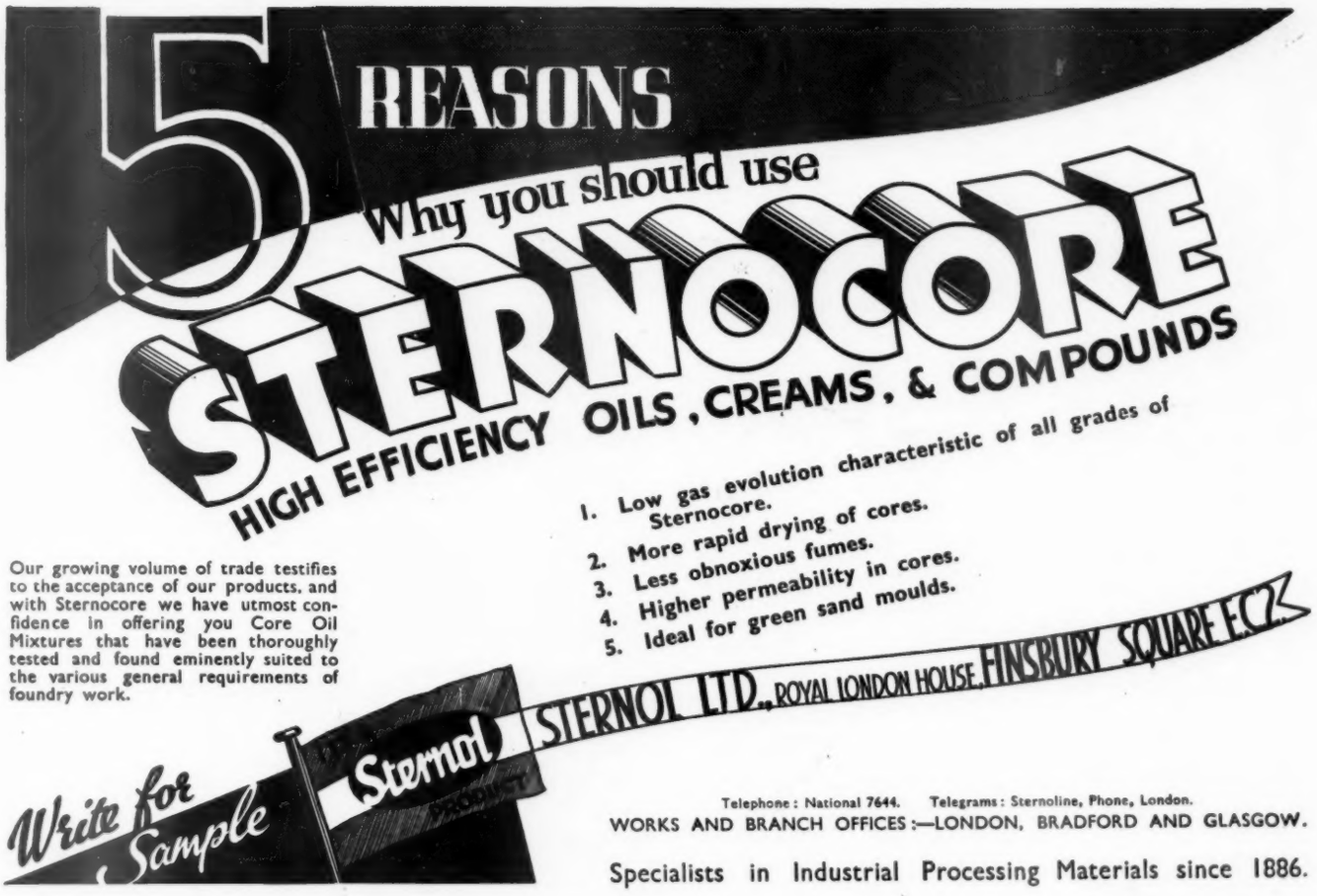
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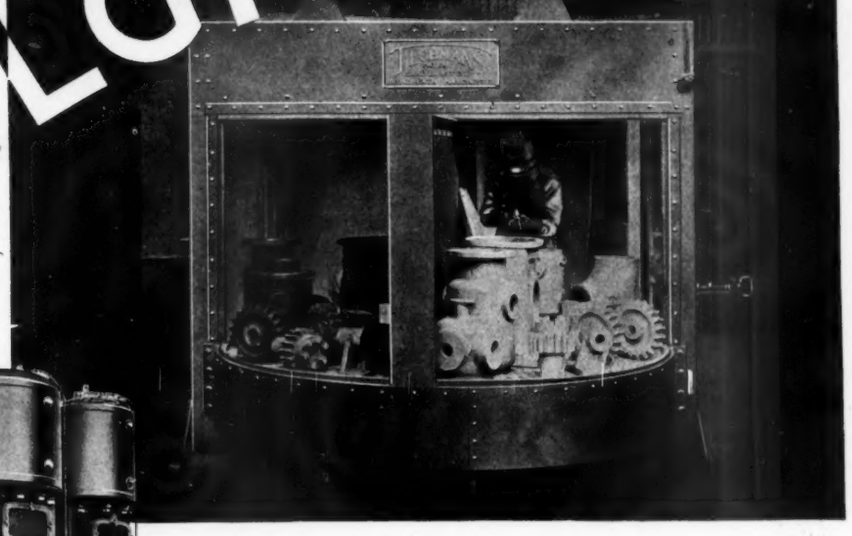

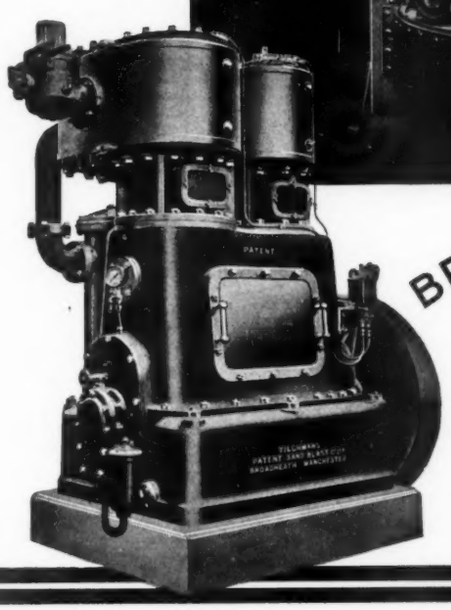

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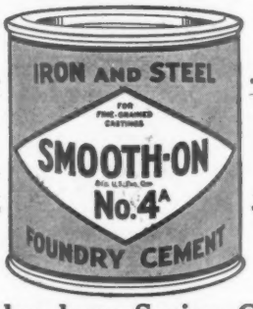

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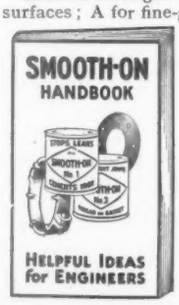

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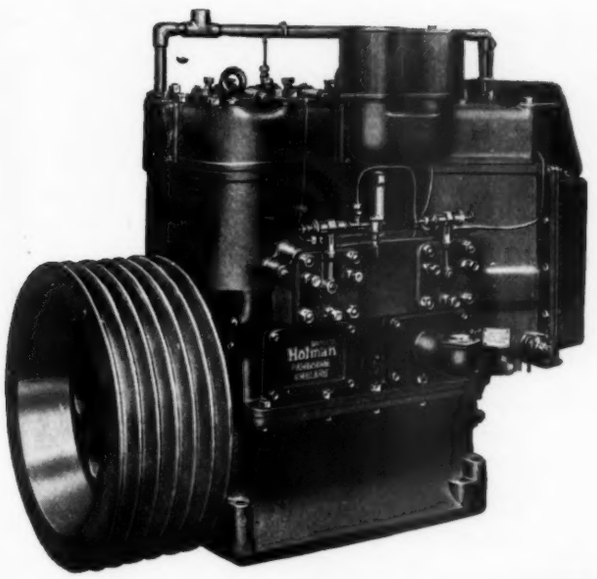

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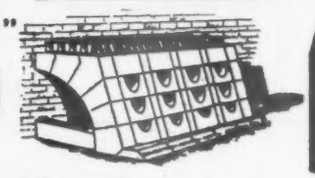

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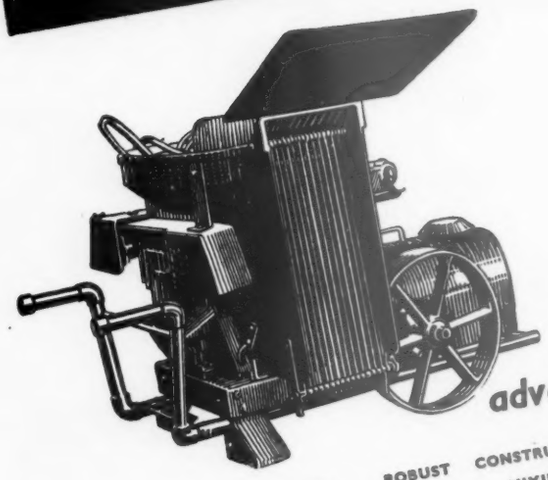

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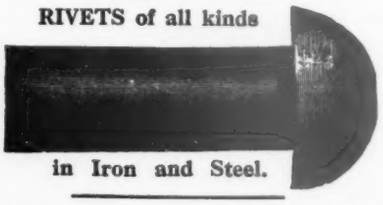

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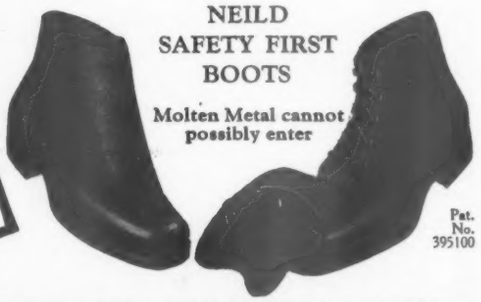

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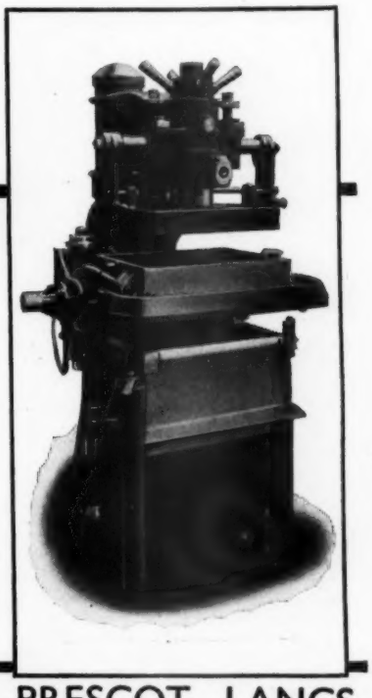

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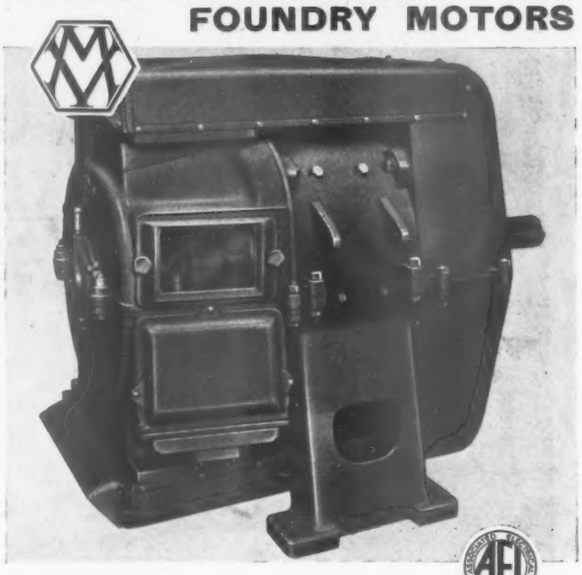

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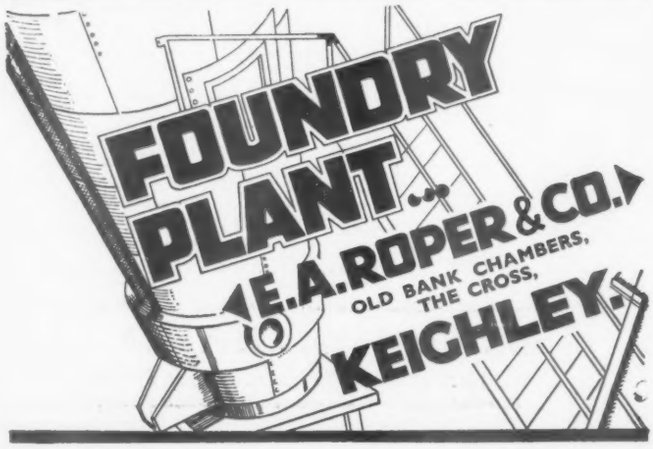
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